JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. 27 OCTOBER 15, 1937 No. 10

HYDROLOGY.—*The chemical character of the ground waters of the South Atlantic Coastal Plain.*[1] MARGARET D. FOSTER, U. S. Geological Survey. (Communicated by OSCAR E. MEINZER.)

The low-lying plain bordering the Atlantic Ocean from the Potomac River and Chesapeake Bay southward to the tip of Florida is here referred to as the South Atlantic Coastal Plain. On the west the plain is bounded by the Piedmont Plateau. The area is part of the Atlantic and Gulf Coastal Plain, a natural physiographic and geologic province of the United States extending from Massachusetts to the Rio Grande.

In the South Atlantic Coastal Plain most of the ground-water supplies are obtained from sedimentary deposits; few wells penetrate to the underlying crystalline rocks. These sedimentary deposits consist of gravel, sand, clay, marl, limestone, and chalk, laid down for the most part under the sea.

Although sodium chloride waters may be encountered near the coast, most of the ground waters obtained from these deposits are bicarbonate waters, with either calcium or sodium as the principal basic constituent. In some waters the proportions of these two basic constituents are approximately equal. Analyses of typical waters in this area are shown graphically in Figs. 1 and 2. The principal soluble material in the sediments is calcium carbonate, with some magnesium carbonate. The clastic constituents of the sands and clays, being the weathered residues of older igneous and sedimentary rocks, have already been more or less altered by hydrolysis and have been leached of their soluble materials. The primary action on the sedimentary deposits, therefore, of meteoric waters containing in solution carbon dioxide derived from the air and soil is solution of calcium and magnesium carbonates. The amount of these carbonates taken into solution depends on the carbon dioxide content of the percolating waters as well as one the calcium and magnesium carbonate content of the sedimentary beds.

[1] Received August 18, 1937. Presented before the Division of Water Sewage, and Sanitation Chemistry at the 93d Meeting of the American Chemical Society, Chapel Hill, N. C., April 12 to 15, 1937. Published by permission of the Director, U. S. Geological Survey.

In deposits that are relatively calcareous, such as sand and clay formations that contain much calcareous cementing material or deposits of marl, limestone, and chalk, the capacity of the percolating waters to take calcium and magnesium carbonates into solution by virtue of their content of carbon dioxide is exhausted at shallow depths. Waters from such formations do not generally increase in mineral content with increasing depth in the formation. Wells 20 to 40 feet deep in these formations yield water containing as much dissolved mineral matter as those several hundred feet deep.

In formations that contain little calcareous material, however, the waters must travel farther to exhaust their capacity to take calcium carbonate into solution. Waters from shallow depths in such formations are usually low in dissolved mineral matter. As the waters percolate downward they continue to take calcium and magnesium carbonate into solution until their carbon dioxide content is exhausted. With greater depth the mineral content then tends to remain relatively constant.

Some formations that are apparently devoid of calcareous material yield waters of low mineral content, even from great depths. Some of these deep waters carry considerable carbon dioxide and are corrosive.

The solution of calcium and magnesium carbonates constitutes the primary action between the percolating meteoric waters and the rock materials. However, many waters of the area are sodium bicarbonate waters, and some contain approximately equal quantities of calcium and sodium.

The same formation may yield waters of all these different types. In such a formation the calcium bicarbonate waters are usually the shallower waters, and the sodium bicarbonate waters are the deeper waters. The waters undergo an alteration in character with depth. The calcium and magnesium content decreases, the waters become softer, and at the same time the sodium content increases, the bicarbonate and total mineral content often remaining about the same. This phenomenon is shown in Fig. 1 by diagrams F, G, H, and I, which represent analyses of waters from different depths in the Black Creek formation in South Carolina. These waters appear to be the result of a secondary action between the waters and the rock materials —exchange of calcium and magnesium in solution in the waters for sodium of base-exchange minerals in the rock materials. Descriptions of the lithologic character of the formations of this area in geologic reports frequently note the fact that a certain formation is "glauconitic." Glauconite, or greensand, is a green granular silicate of

potassium and iron that has pronounced base-exchange properties. It is formed near the mud line off continental shores and is consequently often found in sedimentary deposits like those that underlie this area. Certain hydrous alumino-silicates that are capable of base

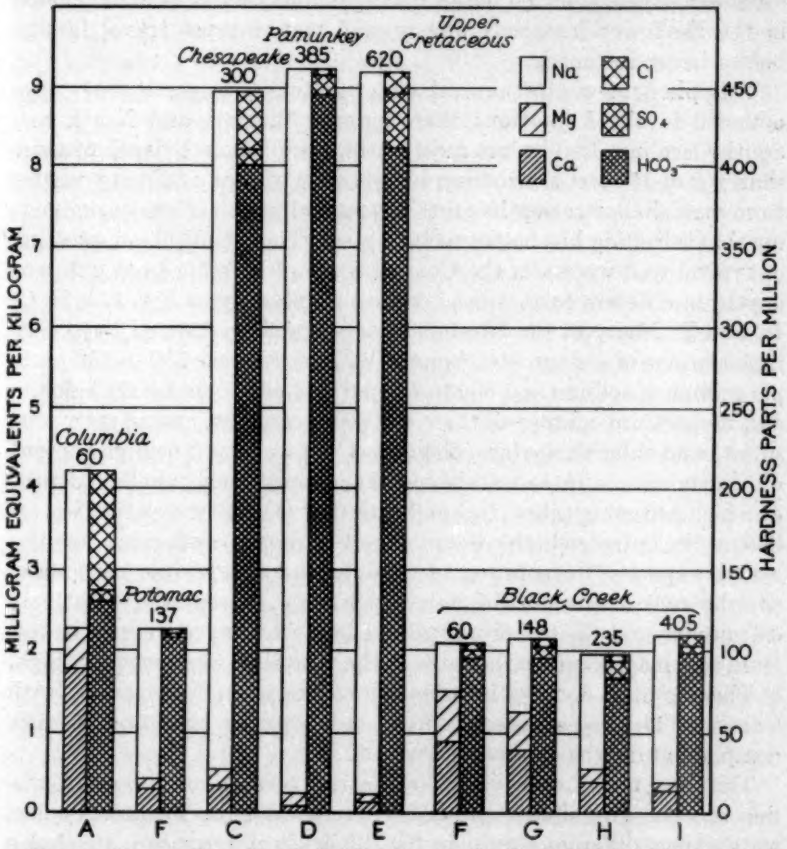

Fig. 1.—Composition of typical well waters in the Coastal Plain of Virginia and South Carolina. (Names above columns refer to stratigraphic units; numbers refer to depth of wells in feet.)

exchange, derived from the weathering of crystalline rocks, may also make up part of the clastic material of these sediments.

The depth at which softening begins varies with the relative proportion of calcium and magnesium carbonates to base-exchange minerals in the materials through which the water passes. If the base-exchange minerals are present in an amount at least proportional to

the carbonates, the two processes are probably almost simultaneous, the calcium being exchanged almost as soon as it is taken into solution. If, however, the carbonates are present in the rock materials in amounts more than equivalent to the exchange minerals, or if the exchange capacity of the base-exchange minerals has been exhausted in the shallower materials, the ground waters must travel farther before being softened.

This phenomenon of natural water softening is particularly pronounced in the formations that underlie Virginia and North and South Carolina. In Virginia most of the waters from a depth of more than 100 or 150 feet are sodium bicarbonate waters, and many waters from even shallower depths contain some sodium bicarbonate, indicating that softening has begun to take place. The chemical composition of typical well waters in the Coastal Plain of Virginia from different depths in different formations is shown graphically on Fig. 1, A, B, C, D, and E. Many of the Virginia waters are characterized by a very high content of sodium bicarbonate, with as much as 250 to 350 parts per million of sodium and 500 to 700 parts of bicarbonate; the calcium and magnesium content of these waters is very low, and in many the sulfate and chloride are low (diagrams C, D, and E). The high content of bicarbonate in these waters and the comparatively shallow depths at which softening takes place indicate that (1) the percolating waters had, at the outset, a high content of carbon dioxide and, consequently, a high capacity for solution of calcium and magnesium carbonate, (2) the rock materials through which they passed were relatively calcareous, and (3) the proportion of base-exchange minerals to calcium and magnesium carbonates in the materials was relatively high.

There is little detailed information on the ground waters of North Carolina. The few analyses at hand indicate that softening is fairly complete at depths of about 100 or 150 feet.

The three most important water-bearing formations in South Carolina are the Tuscaloosa, the Black Creek, and the Peedee. Typical waters from different depths in the Black Creek formation are shown graphically in Fig. 1, diagrams F, G, H, and I. The waters from this formation are usually fairly low in dissolved mineral matter, generally containing less than 200 parts per million. The waters from the Tuscaloosa formation are similar in character to those from the Black Creek formation, although they generally contain less than 150 parts per million of dissolved mineral matter. The waters from the Peedee formation are more highly mineralized, usually having a mineral content of 500 to 750 parts per million. The deeper waters from the

Peedee formation are similar to the highly mineralized sodium bicarbonate waters in Virginia, shown diagrammatically in Fig. 1, C, D, and E. The predominating chemical constituent of the waters in all these formations shows a gradual alteration with increasing depth, from calcium bicarbonate, which characterizes the shallower waters, to sodium bicarbonate, which characterizes the deeper waters. The depth at which softening takes place differs in the different formations. In the Tuscaloosa it apparently takes place at less than 150 feet, in the Black Creek at about 150 to 200 feet, and in the Peedee at about 200 feet. The ground waters from the other formations of South Carolina show the same alteration in character with depth. In the Cooper marl and Santee limestone the softening apparently takes place at a depth between 200 and 300 feet.

The phenomenon of base exchange is much less pronounced in the formations that underlie Georgia. These formations contain a larger proportion of limestone than those in the area to the north. The deep waters, as well as the shallow waters, are for the most part calcium bicarbonate waters, although wells more than 800 feet deep may yield sodium bicarbonate water. This is brought out in Fig. 2, diagrams A, B, C, D, E, and F, which show graphically the composition of typical waters from different depths in different formations in the Coastal Plain of Georgia. The data at hand indicate that the ground waters of Georgia are remarkably uniform in chemical composition, regardless of the formation from which they come. The general range in total dissolved mineral matter for the waters from the various formations is 150 to 250 parts per million, and in total hardness 100 to 200 parts, although there are waters with more dissolved mineral matter or with less. Apparently there is, then, in Georgia, no formation which yields markedly superior or inferior water, and the choice of the proper horizon to tap for a water supply depends on local conditions.

The rocks of Florida are, properly considered, the southward extension of the formations in Georgia and Alabama. In Florida, as in Georgia, calcium bicarbonate waters predominate. The diminution of the tendency of the formations to soften the waters in them, noted in Georgia, is apparently carried to completion in Florida, where a sodium bicarbonate water is rare. Two have been noted in the Okeechobee area. These are from shallow wells, however, and may be considered a local phenomenon. The calcium bicarbonate waters of Florida do not show the same uniformity in chemical composition as those of Georgia. The range in total dissolved mineral matter is

greater, and the relative content of the different constituents is much more variable. In this respect the relative amounts of calcium and magnesium are particularly to be noted. In some waters the calcium content is relatively high and the magnesium content is very low, as

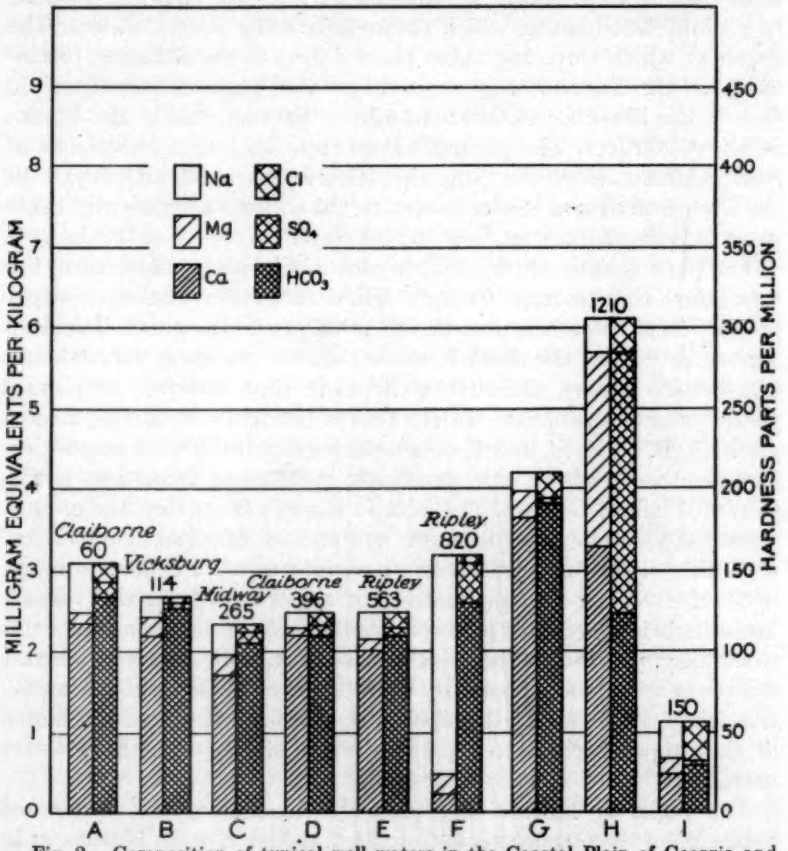

Fig. 2.—Composition of typical well waters in the Coastal Plain of Georgia and in Florida. (Names above columns refer to stratigraphic units; numbers refer to depth of wells in feet.)

shown in diagram G in Fig 2; in others these two constituents are present in almost equivalent amounts, as shown in diagram H, Fig. 2. In general, waters containing more than 400 parts per million of total solids and having a total hardness of more than 400 parts have, proportionately, considerably more sulfate and chloride than waters containing less than 400 parts of total solids, although some waters

with less than 400 parts of dissolved mineral matter also contain notable quantities of these constituents. The best water is generally obtained from the younger formations. These deposits usually yield soft water of low mineral content (Fig. 2, I), but in some areas they may not yield enough water for more than small domestic supplies.

Near the coast along the whole area another factor may enter in the determination of the chemical character of the waters. Most of the formations are assumed to have submarine outcrops. If the head of fresh water in a formation is sufficient to balance the head of heavier sea water, which tends to force salt water into the formation at its submarine outcrop, salt water will not enter the formation, and the normal chemical relations of the waters in the formation will be undisturbed. If, however, the fresh-water head is not sufficient, sea water will enter the formation to the point where it is balanced by the fresh-water head. If this point lies somewhere inland from the coast line, salty waters will be encountered by wells drilled into the formation between this point and the coast. The chemical composition of many of these salty waters shows them to be normal ground waters to which more or less sea water has been added. Formations containing fresh water may be found below those containing salt water. As a rule, however, the probability of finding fresh water below salty water is slight. The problem of finding sufficient fresh water for a municipal supply is a serious one for many cities on the coast. The deep formations may all yield salty water, and the superficial deposits, while yielding fresh water, may not yield a sufficient supply for the use of a city. Away from the coast salt water from deep wells may represent an admixture of meteoric water with sea water entrapped in the formation at the time of its deposition. Waters of high chloride content are also obtained from many shallow wells throughout the area. In many of these waters the high chloride is accompanied by high nitrate, which is usually derived from the oxidation of nitrogenous organic matter.

Waters in which sulfate is the predominant acidic constituent are comparatively rare in this area. They are usually of only local occurrence and the result of strictly local conditions. As a rule sulfate is a subordinate constituent in the ground waters of the South Atlantic Coastal Plain.

In general, then, the wells of shallow or moderate depths in Virginia and North and South Carolina yield calcium bicarbonate waters, the deep wells yield sodium bicarbonate waters; both shallow and deep wells in Georgia and Florida yield calcium bicarbonate waters;

but along the whole coast these normal ground-water relationships may be disturbed by the admixture of more or less sea water with the normal ground waters.

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BOTANY.—*New species of* Sphaceloma *on* Aralia *and* Mentha.[1]

ANNA E. JENKINS, Bureau of Plant Industry. (Communicated by JOHN A. STEVENSON.)

Four new American species of *Sphaceloma* were listed in a synoptic table (table 1) included in a paper presented at Rio de Janeiro, in January, 1936, giving the known species of *Elsinoe* and *Sphaceloma.*[2] Names and brief descriptions of the two North American species are here supplied. The two from South America will be named and described elsewhere.

Sphaceloma araliae sp. nov.

Produces conspicuous spots or galls on stems and leaves, including midrib and veins; spots solitary or closely grouped, linear to elliptical or elongate, or, particularly on leaves, circular to irregular, up to 12 mm long by 5 mm wide, ocher red,[3] becoming pale ochraceous buff in central region; acervuli erumpent superficial, 20–50μ in diam., often continuous over large areas; hyphae or stromata hyaline; stromata reaching 80μ in thickness; palisade of conidiophores compact, light fulvous, often 8–20μ thick; conidia oblong-elliptical, 1-celled, hyaline, 5–10μ×2.5–4μ (measurements include conidia in culture); on potato-dextrose-agar medium, thallus ochraceous tawny.

Macules vel gallas insignes, 5 mm latas, 12 mm longas, ochraceorubras, in centro ad ochraceo-alutaceas pallescentes, in caulibus et foliis producens; acervulis erumpente superficialibus, 20–50μ in diam., saepe per superficientem latam continuis; stromatibus saepe bene evolutis, usque 80μ crassis, hyalinis; palis conidiophorum compactis, crassis, pallide fulvis; conidiis unicellularibus, oblongo-ellipticis, hyalinis, 5–10μ×2.5–5μ.

On living stems and leaves of *Aralia spinosa* L., causing a scab disease, Edgewater, Md., July 2, 1934, Peter Bisset. In the Mycological Collections of the Bureau of Plant Industry (No. 69462, type), and in Phytopathological Herbarium, Instituto Biologico, São Paulo, Brazil.

[1] Received September 14, 1937.

[2] JENKINS, A. E. and A. A. BITANCOURT, *Doenças das plantas causados por fungos dos generos* Elsinoe e Sphaceloma. Rodriguésia 2: (Numero especial. Annaes da Primeira Reunião de Phytopathologistas do Brasil) 305–313. 2 tables. 1936.

[3] RIDGWAY, R. *Color standards and color nomenclature,* 43 pp. 1912.

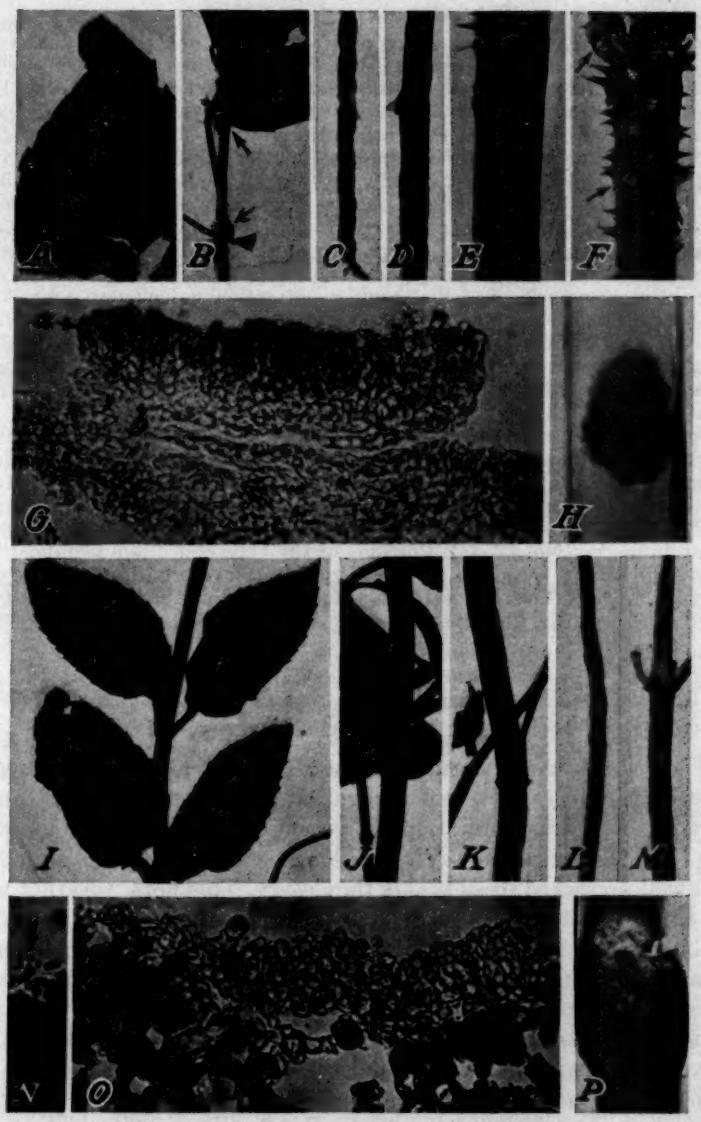

Fig. 1, A–G.—*Sphaceloma araliae* on *Aralia spinosa*. A–D, on leaf parts, E and F, on stem; G, acervulus, *a*, palisade of conidiophores, *b*, underlying stems. A–F, ×1; G, ×400. H, 25-day-old culture of the fungus on potato-dextrose agar. ×1.

I–O.—*S. menthae* on *Mentha piperata*. I, on leaves, J–N, on stems, M, on rootstock; N, conidia, and C, acervulus on upper surface of leaf; I–M, ×1; N and O, ×400. P, old culture on oatmeal agar. ×1.

Sphaceloma menthae sp. nov.

Produces spots on leaves, stems and rootstocks; spots often numerous, raisin black, central part becoming pallid to pale vinaceous drab, circular to elliptical or irregular, up to 3–5 mm in diam.; stem lesions at first sunken, sometimes elevated, often becoming crateriform with concavity light-colored; acervuli erumpent superficial, more or less hemispherical or flattened, 15–80μ or more in diam.; palisade of conidiophores compact, very light yellow, 10–25μ thick; conidia spherical to elliptical, hyaline, 3–8μ $\times$2.5–4μ. Characters of thallus in culture resembling those of *Myriangium*. Color of young thalli on potato dextrose agar medium Varley's brown surrounded by Hay's maroon, older pubescent thalli pallid to light brownish drab, medium becoming light yellowish olive (Fig. 1, I–P).

Maculis numerosis, in foliis, caulibus et radicibus, purpureo-nigris, in centro pallidis ad pallide vinaceo-griseis, ellipticis vel rotundis vel irregularibus, 3–5 mm in diam., vel in caulibus interdum extensis et saepe crateriformibus; acervulis erumpente superficialibus, 15–80μ in diam. vel amplioribus; palis conidiophorum compactis, 10–25μ crassis; conidiis sphaericis ellipticisve, hyalinis, 3–8$\times$2.5–4μ.

On leaves, stems, and rootstocks of cultivated *Mentha piperata* L., causing the disease known as leopard spot, Lafayette, Ind., Aug. 21, 1934, R. C. Baines; Breeman, Ind., Sept. 1, 1937, H. A. Edson; Mentha, Mich., Aug. 3, 1937, Ray Nelson and Anna E. Jenkins; and July 31, 1935, and Aug. 20 and 29 (type), 1937, Ray Nelson. Type in the Mycological Collections of the Bureau of Plant Industry (No. 72538). Portions of the type collection also deposited in the following herbaria: Farlow Cryptogamic Herbarium of Harvard University, New York Botanical Garden, Herbarium of the University of Michigan, and the Phytopathological Herbarium, Instituto Biologico de São Paulo, Brazil.

PALEOBOTANY.—*Fossil legumes from Bridge Creek, Oregon.*[1] ROLAND W. BROWN, U. S. Geological Survey.

The reddish shales occurring along Bridge Creek, 9 miles northwest of Mitchell, Ore., and recognized as equivalent to the upper part of the Clarno formation (Oligocene, according to the usage of the U. S. Geological Survey), have long been noted for the abundant and well-preserved fossil plants they carry. This flora, together with that from similar rocks of the same or approximately the same age and horizon in the Crooked River basin, 35 miles southward, includes ferns, pines, firs, sequoias, cattails, willows, sweet-ferns, hazelnuts, hornbeams, ironwoods, alders, beeches, chestnuts, oaks, hickories, elms, hackberries, barberries, umbellularias, sycamores, mock-oranges, service-berries, hawthorns, lindens, black-gums, sweet-gums, dogwoods, and madrones. Although this flora is, relatively speaking, fairly large and well known, it is nevertheless possible to find new species, even among the old collections, as was my good fortune recently when, for other reasons than looking for a new species, I had

[1] Received July 29, 1937.

occasion to split a piece of the shale from Bridge Creek. To my surprise the unusually fine legume pod illustrated in Fig. 1 was uncovered. This pod belongs to a species of *Cladrastis*, a genus hitherto unreported from Bridge Creek, and may be described as

Cladrastis oregonensis Brown, n. sp. Fig. 1

Description.—A linear-compressed pod, 6.5 cm long and 1.2 cm wide, with acute apex and base, the latter surrounded by the remains of the campanulate calyx. The placental suture line is marked by a wide keel or wing, but the other margin does not appear to be appreciably winged. One large

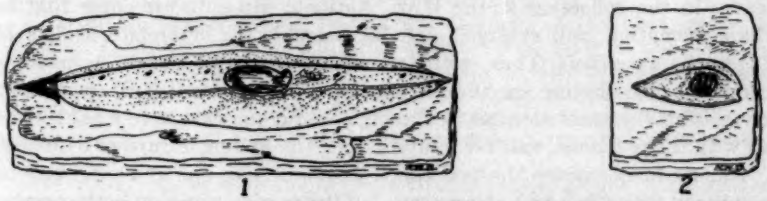

Fig. 1.—*Cladrastis oregonensis* Brown, n. sp. Fig. 2.—*Micropodium ovatum* (Lesquereux) Brown, n. comb. Both specimens are from the reddish shales along Bridge Creek, 9 miles northwest of Mitchell, Ore. Natural size.

oblong seed, 1 cm long and 5 mm wide, has a position near the center of the pod. It is attached at the upcurved end to the placenta, the free rounded end pointing backward to the base of the pod so that the long axis of the seed is parallel to the placental line. Five minute aborted seeds of the same shape as the large seed are also present. Only a faint suggestion of reticulate veining is preserved on the pod in the region near the large seed.

Occurrence.—In reddish shales along Bridge Creek, 9 miles northwest of Mitchell, Ore.

Type.—Deposited in the U. S. National Museum.

Remarks.—The characters displayed by this fossil pod are distinctive and indicate the genus *Cladrastis*. Confusion might be made with the pods of *Robinia*, which resemble those of *Cladrastis* closely, but the pods of *Robinia* are in general blunter at both ends, and its seeds are about two-thirds the size of those of *Cladrastis*, with their long axes somewhat oblique to the placental line. I have, however, been unsuccessful in matching the fossil exactly with typical pods from any of the 4 or 5 living species of *Cladrastis*. Most of the pods of *C. lutea*, the yellow-wood of a restricted area in the southeastern United States, have a comparatively narrow wing along the placental suture. The other species are natives of eastern Asia, and among these the best matches for the fossil are the pods of *C. amurensis*, which compare well in wing characters but are somewhat more rounded at the apex.

The leaves of *Cladrastis* are odd-pinnate, with leaflets that vary from broadly oval in *C. lutea* to oblong and lanceolate in some of the Asiatic species. It would seem that a scrutiny of the more or less doubtfully assigned

fossil leaves from Bridge Creek might give a clue to the probable affinity of the fossil pod with living species of *Cladrastis*. At least two kinds of such leaves, present in the collections, may be leguminous. They are the leaves identified as *Fraxinus denticulata* Heer?[2] and some of those originally called *Fraxinus integrifolia* Newberry[3] but now *Umbellularia oregonensis* (Knowlton and Cockerell) Chaney.[4] The enlarged petioles and the secondary venation of *Fraxinus denticulata* can be matched fairly closely in some of the leaflets of *Cladrastis lutea* and some Asiatic species of *Cladrastis*. As for *Umbellularia oregonensis*, there seems to be little question that most of the leaves assigned to that species are *Umbellularia*. However, among these leaves in the collection at the U. S. National Museum are some that in shape, venation, and enlarged petioles resemble the lanceolate leaflets of *Cladrastis amurensis*. Thus, with two sets of leaves or leaflets as possible candidates for sharing specific relationship with the fossil pod, apparently no satisfactory conclusion can be drawn, and the question as to what leaflets go with the pod must wait for solution upon the finding of further evidence.

Among fossil species the pod called *Leguminosites* sp. by Dorf,[5] may be compared with *Cladrastis oregonensis*, but it has wide wings on both margins and thus resembles the living *C. platycarpa* of Japan. This pod also belongs to a later geologic horizon than *C. oregonensis*. The pod described as *C. eocenica* Berry[6] from the Eocene of Tennessee may belong to *Cladrastis*, but as figured it does not show the shape and posture of the seeds and thus fails to be entirely convincing.

Two other kinds of leguminous pods have been described from the shales of Bridge Creek and Crooked River, Ore. One of these is *Cercis* sp. from Crooked River.[7] This is the distal half of a pod showing a thick suture line and three elliptic to circular seeds. The shape of these seeds clearly distinguishes this pod from *Cladrastis oregonensis*. LaMotte[8] has synonymized *Cercis* sp. with *Cercis spokanensis* Knowlton[9] from the Latah formation. It seems to me, however, that La-

[2] NEWBERRY, J. S. *The later extinct floras of North America.* U. S. Geol. Survey Mon. 35: 128, pl. 49, fig. 6, 1896.—CHANEY, R. W. *Geology and paleontology of the Crooked River Basin, with special reference to the Bridge Creek flora.* Carnegie Inst. Wash. Pub. 346 (pt. 4): 132, pl. 19, figs. 5–7, 1927.

[3] NEWBERRY, J. S. Op cit., p. 128, pl. 49, figs. 1–3.

[4] CHANEY, R. W. *A record of the presence of* Umbellularia *in the Tertiary of the western United States.* Carnegie Inst. Wash. Pub. 349 (pt. 4): 60, pl. 1, figs, 1, 3, 5, 7, 1925.

[5] DORF, ERLING. *A late Tertiary flora from southwestern Idaho.* Carnegie Inst. Wash. Pub. 476 (pt. 2): 119, pl. 3, fig. 1, 1936.

[6] BERRY, E. W. *Revision of the lower Eocene Wilcox flora of the southeastern States.* U. S. Geol. Survey Prof. Paper 156: 84, pl. 41, fig. 12, 1930.

[7] CHANEY, R. W. Op cit., Pub. 346 (pt. 4): 125, pl. 15, fig. 5, 1927.

[8] LAMOTTE, R. S. *The upper Cedarville flora of northwestern Nevada and adjacent California.* Carnegie Inst. Wash. Pub. 455 (pt. 5): 132, pl. 10, fig. 4, 1936.

[9] KNOWLTON, F. H. *Flora of the Latah formation of Spokane, Washington, and Coeur d'Alene, Idaho.* U. S. Geol. Survey Prof. Paper 140: 43, pl. 29, fig. 9, 1926.—BROWN, R. W. *Additions to some fossil floras of the western United States.* U. S. Geol. Survey Prof. Paper 186: 177, pl. 54, figs. 10–12, 1937.

Motte's figured specimen from 49 Camp, Washoe County, Nev. is not *C. spokanensis*, nor is it the same species as the Crooked River specimen, for the latter appears to be more membranous and lacks the wide wings on the margins. The other species of pod is that originally called *Ailanthus ovata* Lesquereux but now

Micropodium ovatum (Lesquereux) Brown, n. comb. Fig. 2

Ailanthus ovata Lesquereux, U. S. Geol. Survey Terr. Rept. 8:254, pl. 51, figs. 7, 8. 1883. [Fig. 8 is a branch, probably unidentifiable, and therefore not further considered here.]

Knowlton, U. S. Geol. Survey Bull. 204: 69. 1902.

Description.—Small oblong-ovate pods, rounded at the apex, acute at the base, 1.5 cm long and 8 mm wide, with a broad wing on the placental suture line. In Fig. 2 the apex is broken and the base is slightly eroded. Seeds apparently one to several, elliptic, 2 mm long, with the long axis perpendicular to the placental line. No venation appears to be present on the specimens. Such markings or striations as have been reported seem to have been caused by the processes of fossilization.

Occurrence.—In reddish shales along Bridge Creek, 9 miles northwest of Mitchell, Ore.

Type.—The original figured specimens are at the University of California. Fig. 2 is in the U. S. National Museum.

Remarks.—These small pods are obviously those of a species of legume and not of *Ailanthus*, for they show neither the longitudinal veins and reticulations, nor the small notch or emargination that is usually present on the wing beneath the seed of *Ailanthus*. Characteristic samaras of *Ailanthus americana* Cockerell are present in the flora from the Green River formation and in that from the Florissant lake beds but they can be distinguished readily from these pods.

Because of their nearly uniform small size these pods seem to represent a single species distinct from that called *Cercis* sp. by Chaney, referred to above. Although *Cercis* leaves are known from the Florissant lake beds, the Latah formation, and other strata in the regions adjacent to the John Day Basin of Oregon, none have yet been identified as such from the shales of Bridge Creek and Crooked River in the latter area. Nevertheless *Cercis* sp. appears to be a true *Cercis*. It is possible that the small pods under discussion here may be the dwarf pods of that species, but until more conclusive evidence appears it seems desirable to regard them as distinct and to adopt Saporta's generic name for similar pods from the Tertiary of southeastern France, his type being *Micropodium oligospermum*.[10] Saporta himself found it difficult to distinguish his specimens from *Cercis* but concluded that because they were apparently produced in a raceme they should be considered as belonging to a different genus. If these fruits were produced in a raceme it is possible that they too may represent *Cladrastis*, resembling the smaller

[10] SAPORTA, G. DE. *Études sur les végétation du sud-est de la France a l'époque tertiare.* 1: 137, pl. 14, figs. 8A, 8B, 1863.—Suppl. 1. *Révision de la flore des gypses d'Aix.* 3: 221, pl. 18, fig. 1, 1873.

pods of *C. platycarpa* of Japan. What appear to be 2 or 3 closely spaced seeds may in reality be folds in the pod overlying a single large seed. If this interpretation be the correct one, then it is possible that the aforementioned specimen referred by LaMotte to *Cercis spokanensis* and the strikingly similar specimen called *Dalbergia? coloradensis* Knowlton[11] from the Florissant lake beds, may also be large specimens of this or a closely related species of *Cladrastis*.

Obviously, not having Saporta's specimens at hand, it is impossible to make detailed comparisons between them and *Micropodium ovatum*. Superficially they seem to be identical species, but only a comparison of the specimens can establish the fact.

The known fossil legumes from the shales on Bridge Creek and Crooked River, Ore., now appear to be: *Cercis* sp., *Cladrastis oregonensis*, and *Micropodium ovatum*—all represented by pods. No leaves have yet been identified as definitely leguminous, although suspicion rests upon several species now assigned to other genera.

ZOOLOGY.—*New rodents from Middle America.*[1] E. A. GOLDMAN, Bureau of Biological Survey.

Studies of the genera *Heteromys* and *Nyctomys* have resulted in the detection of the new subspecies here described. Two of these were obtained by the veteran collector, C. F. Underwood, who has been making notable contributions to knowledge of the fauna of Costa Rica for many years. Specimens of a new subspecies of *Nyctomys*, from Salvador, have been made available through the courtesy of Mrs. Florence V. V. Dickey.

For the loan of other specimens required for comparison in this connection my thanks are due to Dr. Roy Chapman Andrews, Dr. H. E. Anthony, George G. Goodwin, and John Eric Hill, American Museum of Natural History, New York, and to Dr. Glover M. Allen, Museum of Comparative Zoology, Cambridge, Massachusetts.

Heteromys desmarestianus planifrons, subsp. nov.

Pirris Spiny Pocket Mouse

Type.—From San Geronimo, Pirris, western Costa Rica. No. 250348, ♀ adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by C. F. Underwood, April 12, 1931. X-Catalog number 26914.

Distribution.—Western Costa Rica; limits of range undetermined.

General characters.—Closely resembling *Heteromys desmarestianus desmarestianus* of Guatemala; color, general size and proportions very similar, but dusky of forearms tending to extend farther down on wrists; pelage

[11] KNOWLTON, F. H. *Fossil plants from Florissant.* U. S. Nat. Mus. Proc. 51 (2151): 278, pl. 19, fig. 4, 1916.

[1] Received May 24, 1937.

sparser; light tawny lateral line usually present as in *desmarestianus;* skull usually broader and differing in other details. Similar to *Heteromys desmarestianus fuscatus* of central Nicaragua, but larger; light tawny lateral line usually present (usually absent or indistinct in *fuscatus*); cranial features distinctive. Not very unlike *Heteromys desmarestianus repens* of the mountains of western Panama, but larger with relatively larger ears; pelage coarser and sparser; differing otherwise in about the same characters as from *fuscatus*. Smaller than *Heteromys oresterus* of the Cordillera de Talamanca; pelage more bristly; slender hairs among bristles deeper ochraceous buff; ears without white edging usually in *oresterus*.

Color.—Type: Upper parts blackish, becoming very dark brown or "mouse gray" (Ridgway, 1912) along flanks and outer sides of limbs, the slender light tawny hairs present but inconspicuous among the bristles; entire under parts, feet, and a line down inner side of hind leg to metatarsus white; a narrow but distinct light tawny line of demarcation along flanks; ears blackish; tail brownish above, whitish below, becoming dusky all around at tip.

Skull.—Large, with broad braincase and broad frontal and parietal regions. Closely resembling those of *desmarestianus* but usually broader, the lateral margins of frontals somewhat more prominent and projecting as supraorbital shelves; interparietal broader, more extended transversely, more evenly oval in outline, the anterior angle less developed; supraoccipital more produced on the median line, tending to bulge farther posteriorly over foramen magnum; dentition about the same. Similar to those of *fuscatus* and *repens*, but larger; interparietal relatively broader, with less evident anterior angle; supraorbital ridges more projecting and shelf-like. Compared with that of *oresterus* the skull is relatively shorter and broader; nasals about conterminous with premaxillae posteriorly (premaxillae extending well beyond nasals in *oresterus*); supraorbital ridges more projecting; angle of mandible more everted; tubercle over root of lower incisor more prominent; molariform toothrows narrowed posteriorly (sides of toothrows nearly parallel in *oresterus*); posterior upper molar smaller, the closure of the reëntrant angles through wear leaving smaller enamel islands.

Measurements.—Type: Total length, 303 mm; tail vertebrae, 169; hind foot, 35. An adult female topotype: 302; 174; 35. *Skull* (type): Greatest length, 37.7; zygomatic breadth, 18.1; interorbital breadth, 9.9; length of nasals, 16.3; width across squamosals in front of auditory meatus, 16.3; interparietal, 9.8×4.9; maxillary toothrow (alveoli), 5.5.

Remarks.— Heteromys d. planifrons is a rather slightly differentiated form bearing a closer resemblance to typical *desmarestianus* than to some of its nearer geographic neighbors. Comparison of 13 topotypes of *Heteromys desmarestianus psakastus* of Salvador with series of *desmarestianus* assumed to be typical from Chipoc and other localities in the Coban region of Guatemala, indicates that the two are identical and that, therefore, *psakastus* does not have to be considered in this connection. The new form requires no close comparison with *Heteromys oresterus*, which is a very distinct species assignable to the subgenus *Xylomys*.

Specimens examined.—Total number, 14, all from western Costa Rica as follows: San Geronimo, Pirris (type locality), 8; Jabillo, 1; Sabanilla, 1; San Ramon, Tres Rios, 4.

Heteromys desmarestianus subaffinis, subsp. nov.

Reventazon Valley Spiny Pocket Mouse

Type.—From Angostura, southern side of Rio Reventazon, opposite Turrialba, Costa Rica (altitude about 1,980 feet). No. 12904/38591, ♂ adult, skin and skull, U. S. National Museum, collected by José C. Zeledon, May 1876. Original number 98.

Distribution.—Rio Reventazon and Pacuare River valleys, eastern Costa Rica; limits of range unknown.

General characters.—Similar in size and color to *Heteromys desmarestianus planifrons* of western Costa Rica, but tawny lateral line apparently absent; cranial details, including the broader rostrum, distinctive. Resembling *H. d. fuscatus* of central Nicaragua, but larger, with broader, more massive skull. Somewhat similar to *H. d. repens* of the mountains of western Panama, but larger; ears relatively larger; skull heavier. Contrasted with *H. d. zonalis* of the Canal Zone, the slender hairs among the bristles are more tawny, and cranial features are quite different.

Color.—Type: Upper parts blackish or very dark brownish, finely mixed with light tawny due to the tone of the slender hairs among the dark bristles; outer sides of forearms, thighs, lower part of rump and scrotum mouse gray; under parts in general, inner sides of forearms, and feet white; light tawny lateral line usually present in some forms of the group absent; ears brownish; tail light brownish above, white below.

Skull.—Very similar in size and general form to that of *planifrons*, but rostrum broader; interparietal narrower, less extended transversely, with more prominent anterior angle; dentition about the same. Differing from those of *fuscatus* and *repens* mainly in decidedly larger size, the supraorbital ridges more strongly developed as projecting shelves. Compared with that of *zonalis* the skull is larger, with much broader braincase and more widely separated supraorbital and temporal ridges, but the rostrum is relatively narrower, the nasals less expanded anteriorly, and the maxillary root of the zygoma much less strongly developed; molariform teeth similar, but incisors relatively narrow.

Measurements.—Type (no body measurements available): Hind foot (dried skin), 34.5 *Skull* (type): Greatest length, 36.9; zygomatic breadth, 17.3; interorbital breadth, 10; length of nasals, 15.9; width across squamosals in front of auditory meatus, 15.8; interparietal, 8.9×5.3; maxillary toothrow (alveoli), 5.5.

Remarks.—Specimens on which this form is based were referred by me (North Amer. Fauna, No. 34, p. 28, 1911) to *Heteromys repens* with the statement that they seemed larger and somewhat different in cranial details. More extended knowledge of the group now seems to warrant their segregation as representatives of a lowland form inhabiting eastern Costa Rica.

Specimens examined.—Four, all from Costa Rica, as follows: Angostura (type locality), 3; Pacuare, 1.

Nyctomys sumichrasti pallidulus, subsp. nov.

Oaxaca Vesper Rat

Type.—From Santo Domingo, 8 miles west of Lagunas, on the Mexican National Railroad, Isthmus of Tehuantepec, Oaxaca, Mexico (altitude 900 feet). No. 73302; ♂ adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, June 13, 1895. Original number 8079.

Distribution.—Known only from the type locality in the Arid Tropical belt on the southern side of the Isthmus of Tehuantepec, Oaxaca; probably has an extensive range in the arid Pacific coast region of southwestern Mexico.

General characters.—Color palest of the known forms of the genus; size medium. Similar to *Nyctomys sumichrasti sumichrasti*, of the eastern slope of the mountains in Vera Cruz and to *Nyctomys sumichrasti salvini* of Dueñas, Guatemala, but upper parts decidedly paler than either—near cinnamon buff instead of tawny; pelage much shorter than in *salvini*.

Color.—Type: Upper parts near "cinnamon-buff" (Ridgway, 1912), purest on head and along sides, including outer surfaces of forearms and thighs, the back inclining toward very light tawny slightly darkened by a thin admixture of dusky hairs; entire under parts white, the line of demarcation along lower part of sides sharp as usual in the genus; ears brownish; fore feet white; hind feet with only a trace of the dusky metatarsal areas so conspicuous in the other subspecies, the toes white; tail unicolor, dark brown.

Skull.—Closely resembling that of typical *sumichrasti*, but broader, with more widely spreading zygomata. Similar to that of *salvini*, but smaller, with relatively smaller molars.

Measurements.—Type: Hind foot measured in flesh, 25 (no other external measurements available). *Skull* (type): Greatest length, 31.3; zygomatic breadth, 17.9; interorbital breadth, 6; greatest width between temporal ridges, 13.4; length of nasals, 11.2; length of anterior palatine foramina, 4.5; length of palatal bridge, 4.8; maxillary toothrow, 4.8.

Remarks.—The geographic races of *Nyctomys sumichrasti* are all very closely allied. *N. s. pallidulus* approaches typical *sumichrasti* which inhabits the humid mountain slopes of eastern Mexico, but the coloration is quite distinctive. As in other species the pale coloration of *N. s. pallidulus* is probably associated with its more arid environment.

Specimens examined.—Five, all from the type locality.

Nyctomys sumichrasti florencei, subsp. nov.

Salvador Vesper Rat

Type.—From Barra de Santiago, Department of Ahuachapan, Salvador (sea level). No. 12765, ♀ adult, skin and skull, collection of Donald R. Dickey, collected by R. A. Stirton, April 6, 1927.

Distribution.—Pacific coastal region of Salvador: altitudinal range from sea level to at least 2,600 feet.

General characters.—Size smallest of the known forms of the genus; color light tawny. Closely resembling *Nyctomys sumichrasti decolorus* of northern Honduras, but very much smaller. Similar to *Nyctomys sumichrasti pallidulus* of Oaxaca, Mexico, but much smaller and color brighter, differing from *Nyctomys sumichrasti salvini* of the high mountains of Guatemala in much smaller size and more vivid coloration.

Color.—Type: Upper parts, including outer surfaces of forearms and thighs, nearly uniform light, but rich tawny, the back faintly lined with black, the dark hairs scarcely numerous enough to alter the general tone; under parts, including inner surfaces of limbs, pure white; ears brownish; fore feet white; hind feet dusky over metatarsus, the toes white; tail unicolor, dark brown. Color varying to light brownish, less vivid tawny in some specimens.

Skull.—Very similar to those of *decolorus*, *pallidulus* and *salvini*, but much smaller than any of these; dentition very light.

Measurements.—Type: Total length, 238 mm; tail vertebrae, 127; hind foot, 21. Average of eight typical adults from Hacienda Chilata, Department of Sonsonate, Salvador (altitude 2,000 feet): 230 (208–255); 117 (107–130); 22.5 (22–23). *Skull* (type): Greatest length, 29; zygomatic breadth, 16.4; interorbital breadth, 5.5; greatest width between temporal ridges, 12.8; length of nasals, 9.2; length of anterior palatine foramina, 4.5; length of palatal bridge, 4.2; maxillary toothrow, 4.1.

Remarks.—The diminutive size and light, but vivid tawny coloration distinguish *Nyctomys s. florencei* from its allies. The type was taken by the collector on a leaning tree in a swamp forest at sea level. This handsome subspecies is named for Mrs. Florence V. V. Dickey, in recognition of her interest in furthering contributions to general knowledge of natural history initiated by her husband, the late Donald R. Dickey, in a wide field.

Specimens examined.—Total number, 14, all from Salvador, as follows: Barra de Santiago (type locality), Department of Ahuachapan, 1; Hacienda Chilata, Department of Sonsonate (altitude 2,000 feet), 10; Lake Olomega, Department of San Miguel (altitude 300 feet), 1; Puerto del Triunfo, Department of Usulatan (sea level), 1; Volcan de San Miguel, Department of San Miguel (altitude 2,600 feet), 1.

Nyctomys sumichrasti costaricensis, subsp. nov.

Costa Rican Vesper Rat

Type.—From San Geronimo de Pirris, hamlet on the main road to Pirris before reaching Jabillo, near the west coast of Costa Rica, about two miles before the abrupt descent to the lowlands of Pozo Azul and about 12 miles inland from Pirris (altitude about 100 feet). No. 250331, ♂ adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by C. F. Underwood, April 12, 1931. X-catalog number 26896.

Distribution.—Valley of the Rio Grande de Pirris, western Costa Rica; limits of range undetermined.

General characters.—A large dark tawny subspecies; anterior palatine foramina about equal in length to palatal bridge (shorter than palatal bridge in neighboring subspecies of the genus). Closely allied to *Nyctomys sumichrasti nitellinus* of the lower slopes of the Volcan de Chiriqui, Panama, but somewhat larger; upper parts brighter, the general tone near tawny instead of cinnamon; incisive foramina distinctly longer. Similar to *Nyctomys sumichrasti venustulus* of the Caribbean coast region of Nicaragua, but somewhat paler, the back less obscured by dusky hairs and differing otherwise in about the same characters as from *nitellinus*.

Color.—Type: Upper parts near "tawny" (Ridgway, 1912), slightly darkened on top of head and over back by a fine admixture of black-tipped hairs; cheeks, flanks, outer sides of forearms and thighs, purer, paler tawny; entire under parts, including lips, inner sides of forearms and thighs white; ears blackish; fore feet white; hind feet dusky over metatarsus, the toes white as in the other members of the genus; tail unicolor, brownish black.

Skull.—Similar to those of *nitellinus* and *venustulus*, but larger than either; nasals more pointed and usually about conterminous with premaxillae posteriorly (usually exceeded by premaxillae in posterior extension in

nitellinus and *venustulus*); anterior palatine foramina longer, about equal in length to palatal bridge (instead of shorter than palatal bridge); dentition similar.

Measurements.—Type: Total length, 270 mm; tail vertebrae, 139; hind foot, 24. An adult male topotype: 246; 126; 25. An old adult female from Jabillo, Pirris: 263; 139; 24. *Skull* (type and an old adult female from Jabillo, Pirris, respectively): Greatest length, 33.3, 31.7; zygomatic breadth, 17.7, 18.4; interorbital breadth, 5.8, 6.5; greatest width between temporal ridges, 14.1, 14.3; length of nasals, 11.6, 10.5; length of anterior palatine foramina, 5.3, 5.2; length of palatal bridge, 5.2, 5.2; maxillary toothrow (alveoli), 5, 4.9.

Remarks.—N. s. costaricensis is distinguished from the neighboring subspecies by rich tawny coloration, and the cranial detail of unusual length of anterior palatine foramina compared with the length of the palatal bridge. In point of size it is about equal to the geographically distant form *N. s. salvini* of Guatemala, but the back less obscured by dusky hairs is brighter tawny; the anterior palatine foramina are longer, and the molars smaller.

Specimens examined.—Total number, 10, all from Costa Rica, as follows: Jabillo, 5; San Geronimo (type locality), 5.

ZOOLOGY.—*Some parasitic copepods from Panama Bay.*[1]

CHARLES B. WILSON, State Teachers College, Westfield, Massachusetts. (Communicated by WALDO L. SCHMITT.)

A small collection of parasitic copepods taken from marine fish in Panama Bay by Dr. A. O. Foster was recently sent to the author for identification. Dr. Foster is helminthologist at the Gorgas Memorial Laboratory of Panama and the copepods were captured during various laboratory investigations. Although the collection includes but eleven species, two of them prove to be new to science, and the male of a third species is here described for the first time. In addition, the host or the locality or both are new for every one of the species.

The Bay of Panama lies off the Pacific end of the Panama Canal and hence is traversed by such shipping as makes use of the canal. In recent years the Galapagos Islands have been a sort of Mecca for many scientific expeditions, the great majority of which have passed through the canal. But, as a rule, the scientists have been so intent upon reaching their ultimate goal that they have made but few investigations enroute.

A notable exception is the Third Hancock Expedition to the Galapagos Islands recently made by the University of Southern California. This expedition did not go through the canal, but went down the Pacific coast of Mexico, Central America, and South

[1] This paper was prepared under the auspices of the Gorgas Memorial Laboratory, Panama, Dr. H. C. Clark, Director. Received August 30, 1937.

America, stopping at many places along the way and securing valuable specimens. The parasitic copepods of that expedition have been reported elsewhere[2] and included some from the Panama coast. This local collection from Panama Bay admirably supplements that list and should serve as an incentive to similar collections from the Pacific coasts of Mexico, Central and South America.

Caligus bonito Wilson

Taken in considerable numbers from the mouth and gill cavity of a bonito (*Sarda* sp.), and in a single instance from the mouth of another bonito identified as *Sarda velox*. The former host is probably the California bonito, *Sarda chilensis*, found on the Pacific coast from San Francisco to Patagonia.

Caligus coryphaenae Steenstrup & Lütken

Three females were taken from the mouth of a bonito (*Sarda* sp.) in company with the preceding species. This copepod is well distributed and has been reported from both sides of the Atlantic, as well as the Pacific.

Caligus diaphanus Nordmann

A single female was taken from the body of the common jack, *Caranx hippos*. This species is even more widely distributed than either of the preceding and infests a great variety of hosts, to which the present record adds one more.

Caligus monacanthi Krøyer

Krøyer founded his new species, *monacanthi*, in 1863 upon a single specimen taken from the skin of a leather fish (*Monacanthus* sp.) in the West Indies. He identified the specimen as a male and gave a detailed description accompanied by 5 figures. Up to the time of the present collection, no further specimens had been obtained during the seventy odd years since the original discovery. Krøyer was in error as to the sex of his specimen, which was certainly a female without egg strings, rather than a male. This mistake, coupled with the entire lack of further specimens, induced the present author, when dealing with the parasites of West Indian fish, to suggest that Krøyer's specimen might well be the undeveloped female of another species.[3] But twenty specimens, including both sexes, taken from the gills of a bonito (*Sarda* sp.) and included in the present collection, definitely prohibit such an inference. The females agree with Krøyer's description and figures in every detail with one exception and, in addition, carry ovisacs to show that they are fully developed. The exception lies in the fact that these Panama specimens have a two-segmented abdomen, while Krøyer's figure represents the abdomen as one-segmented and the text states that it shows no trace of segmentation. But Krøyer does say in parentheses that the abdomen is contracted for a distance at its base and then widens. The jointing is at the

[2] University of Southern California Publications. The Hancock Pacific Expeditions 2 (4): 23–30, pl. 3. 1937.
[3] Proc. U. S. Nat. Mus. 28: 607. 1905.

point where the diameter changes and might easily escape notice, and is scarcely visible in some of the present specimens. A female and male have been selected and given Cat. No. 69867 U.S.N.M.

Female.—Krøyer's statement that this species is marked by an elongation of the carapace, genital segment, and abdomen applies to both sexes. Carapace of female three-sevenths of the entire length and considerably narrowed anteriorly; lunules of medium size and not projecting. Median posterior lobe half the entire width of the carapace, its margin not evenly rounded but with the tip projecting a little. Lateral lobes curved inward and not quite reaching the tip of the median lobe. Free segment two-thirds as wide as the genital segment and strongly narrowed in front of the fourth legs. Genital segment elongate elliptical, three-fourths as long as the carapace, narrowed anteriorly into a short neck and lobed posteriorly. Each of the lobes is as wide as the abdomen, broadly rounded, and does not quite reach the joint in the abdomen. The latter is one-third as wide and nearly as long as the genital segment, and indistinctly two-segmented, the distal segment the longer. Caudal rami nearly as wide as long and well separated. Ovisacs attached to the ventral surface of the genital segment just inside the base of each posterior lobe and as long as the genital segment.

Second antenna large and sickle-shaped; terminal segment of second maxilla slender, longer than the basal segment, with two terminal setae but no lateral spine. Maxilliped with a swollen basal segment and a stout terminal claw. Basipod of first leg with a minute process representing the endopod; terminal segment of the exopod with 3 end spines and a long naked seta, but with no plumose setae on its posterior margin. The armature of the second legs is very peculiar; the basal segment of the exopod carries a long filose spine at the center of the outer margin and a stout spine at the distal corner, bent down across the ventral surface, with a fringe of long hairs between the two spines. The distal segment has 3 setae at its outer corner, flanged on their outer margins and plumed on their inner margins. The basal segment of the endopod has a fringe of small curved spines on the distal half of its outer margin. The second segment has a row of 6 stout spines along its outer margin; the bases of these spines are swollen, cover the whole length of the margin, and are somewhat imbricated. In the third legs the spine on the basal segment of the exopod is nearly straight and reaches the entire length of the second segment. The fourth legs are three-segmented with 5 spines, the second segment as long as the third and the two combined as long as the basal segment, which is moderately swollen. There are no rudiments of fifth legs anywhere visible. Small spherical spermatophores are attached in pairs at the opening of the sperm receptacle.

Total length 4.40 mm. Carapace 2 mm long, 1.90 mm wide. Ovisacs 2 mm long.

Male.—Carapace similar in shape to that of the female, but relatively longer, being just half of the entire length; lunules larger and suborbicular, but scarcely projecting. Posterior median lobe a little more than half the entire width and evenly rounded, extending a little beyond the lateral lobes. Free segment wider than the genital segment, greatly narrowed in front of the fourth legs. Genital segment barrel-shaped, not narrowed to a neck anteriorly and without posterior lobes. Abdomen distinctly two-segmented, the distal segment nearly twice the length of the basal, both segments of the same width throughout with straight sides. Caudal rami nearly twice as long as wide and curved inward. Appendages like those of the female with the following differences.

Maxillary hooks considerably enlarged and strongly curved; maxillipeds with a row of 3 short triangular spines on the inner margin of the basal segment, the terminal claw shutting down against the two distal spines. The claw itself has a slender spine at the center of its concave margin, which is close to the distal spine of the basal segment when the claw is closed. The terminal segment of the first legs carries the usual 3 plumose setae on its posterior margin. In the second legs the fringe of spines on the outer margin of the second segment of the endopod is here replaced by a row of 8 to 10 chitin scales closely imbricated.

Total length 4.50 mm. Carapace 2.25 mm long, 1.90 mm wide.

Remarks.—The armature of the second endopod segment of the second legs in both sexes is not known in any other species of the genus and evidently escaped Krøyer's notice. It lends a distinctive character to the species and with the other details fully establishes its validity after 75 years of waiting.

Caligus patulus, n. sp.

Twelve females were obtained from the outer skin of a milkfish (*Chanos* sp.) captured in the Bay. One of them bearing ovisacs has been chosen as the type of the species with Cat. No. 69869 U.S.N.M.

Female.—Carapace five-eighths of the entire length, almost as wide as long; frontal plates wide and separated by a deep median incision; lunules of moderate size and not projecting. Posterior median lobe half the entire width, with prominent posterior corners; lateral lobes broadly rounded and the same length as the median lobe. Free segment two-fifths as wide as the carapace and thickened through the bases of the fourth legs. Genital segment two-thirds as wide as the carapace and almost twice as wide as long, contracted to the width of the free segment where it joins the latter, Its posterior lobes are broadly rounded and carry rudiments of the fifth and sixth pairs of legs and wide processes at their inner corners, giving them a sinuous outline. The abdomen is quadrangular and one-segmented, as wide as long; the caudal rami are also as wide as long and well separated at the posterior corners of the abdomen. The ovisacs are a little narrower than the abdomen and two-thirds as long as the entire body.

The antennae and maxillae are of the usual pattern; the claw of the maxilliped is as long as the basal segment and abruptly bent near the tip. The basal segment of the first leg has at its posterior distal corner a finger process tipped with a short spine representing the endopod. The proximal segment of the exopod has a fringe of hairs on its posterior margin, and a spiny process at its anterior distal corner; the end segment has two terminal claws and three stout plumose setae. In the third legs the spine on the basal segment of the exopod is short and blunt, and the two rami are close together. The fourth legs are three-segmented with four spines; the second segment is longer than the third and the two combined are the same length as the basal segment. The fifth and sixth legs are represented by small processes tipped with minute setae. The base of the furca is longer than wide, the arms are shorter than the base, nearly parallel and flattened.

Total length 6 mm. Carapace 3.60 mm long, 3.59 mm wide.

Remarks.—The distinguishing characters of this species are the large and roomy genital segment (whence the specific name) with its sinuous posterior

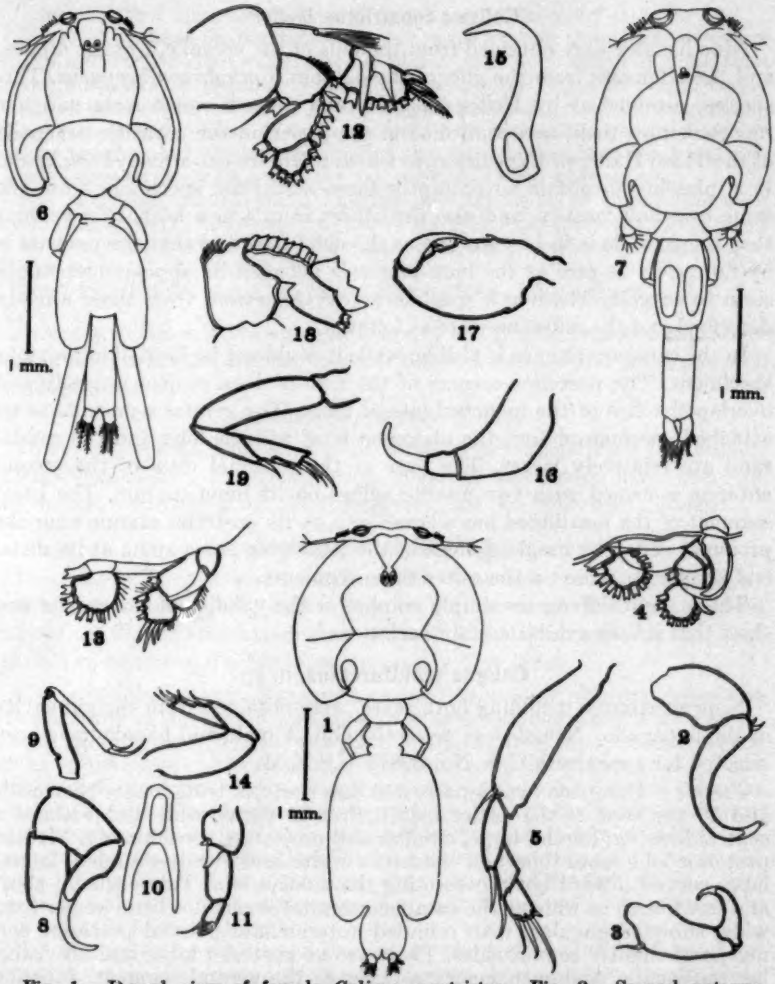

Fig. 1.—Dorsal view of female *Caligus constrictus*. Fig. 2.—Second antenna. Fig. 3.—Maxilliped. Fig. 4.—Third leg. Fig. 5.—Fourth leg. Fig. 6.—Dorsal view of female *Caligus monacanthi*. Fig. 7.—Dorsal view of male. Fig. 8.—Second antenna of female. Fig. 9.—Second maxilla. Fig. 10.—Furca. Fig. 11.—First leg. Fig. 12.—Second leg. Fig. 13.—Third leg. Fig. 14.—Fourth leg. Fig. 15.—Maxillary hook of male. Fig. 16.—Second antenna. Fig. 17.—Maxilliped. Fig. 18.—Second leg. Fig. 19.—Fourth leg.

lobes, and the long fourth legs, which reach beyond the posterior margin of the genital segment. The relative lengths of the second and third segments in these fourth legs are also useful for identification since it is usual for the third segment to be the longer.

Caligus constrictus Heller

Nine females were obtained from the gills of the crevalle, *Caranx hippos*, and three females from the gills of the dolphin, *Coryphaena hippurus*. This species, established by Heller 72 years ago upon a single male and not reported since then, was confirmed in the paper on the parasitic copepods of the Third Hancock Expedition, to which reference has already been made. It is pleasing to obtain so promptly these additional specimens from the same host and locality, and also the others from a new host. It is evident that the crevalle is to be regarded as the chief host and that the parasite is by no means as rare as the long intervals between its appearances would seem to suggest. These new specimens vary somewhat from those already described and the differences are as follows.

In the carapace the eye is visible, while it could not be located in previous specimens. The posterior corners of the median lobe project laterally and overlap the tips of the incurved lateral lobes. The genital segment has no attached spermatophores, the abdomen is as wide as long and the caudal rami are relatively larger. The base of the terminal claw of the second antenna is armed with two minute spines on its inner margin. The basal segment of the maxilliped has a small seta on its posterior margin near the proximal end. The basal segment of the fourth leg has a spine at its distal end similar to those on the other three segments.

These slight differences simply emphasize the validity of the species and show that it does exhibit certain variations.

Caligus tenuifurcatus, n. sp.

Nine specimens, including both sexes, were obtained from the gill cavity of the papagallo, *Nematistcus pectoralis* Gill. A male and female have been selected for types with Cat. No. 69874 U.S.N.M.

Female.—Carapace ovate, narrowed anteriorly, a trifle longer than wide and 40 per cent of the entire length; frontal plates wide and without a central incision; lunules large, circular and projecting considerably. Median posterior lobe more than half the entire width and evenly rounded; lateral lobes curved inward but not meeting the median lobe. Free segment short and one-fourth as wide as the carapace; genital segment a little longer than wide, subquadrangular, with rounded anterior and pointed posterior corners, and slightly convex sides. There are no posterior lobes and no visible leg rudiments. Abdomen nearly as long as the genital segment, tapering a little posteriorly and two-segmented, the distal segment longer than the proximal. Caudal rami twice as long as wide, close together and curved inward. Ovisacs as long as the urosome and somewhat divergent.

First antennae short and turned backward; second antenna stout, its terminal claw bent into a half circle. Basal segment of maxilliped also stout, the terminal claw half as long as the segment with two unequal small spines near the center of its concave margin. Rudimentary endopod of the first legs a very small triangular spine; end segment of exopod with three terminal claws and a much longer spine, and three plumose setae. Fourth leg three-segmented with six spines, including the very small one at the tip of the basal segment. Second and third segments of equal length and together as long as the basal segment.

Total length 5 mm. Carapace 2.10 mm long, 2 mm wide.

Male.—Carapace proportionally larger, a little more than half the entire length and longer than wide; frontal plates with even larger lunules than in the female. Free segment wider than the genital segment and strongly contracted anteriorly. Genital segment a parallelogram, one-half longer than wide, with straight sides. Abdomen a trifle longer than the genital segment and two-segmented, the distal segment one-third longer than the proximal. Caudal rami twice as long as wide and curved inward at their tips.

The antennae, mouth parts, and legs are like those of the female with minor differences. The furca, like that of the female, is more than four times as long as wide, with slender and slightly divergent arms about as long as the base.

Total length 5.40 mm. Carapace 2.81 mm long, 2.50 mm wide.

Remarks.—The relative size and shape of the genital segment and abdomen in both sexes are characteristic of this new species and will serve well for identification.

Gloiopotes costatus Wilson

Thirty specimens, including both sexes, were taken from the outside surface of a sailfish, *Istiophorus greyi*. Some of these were larger than the dimensions originally given for the species, but not otherwise different.

Lernaeenicus longiventris Wilson

Two mature females and a development stage were taken from the body wall of the common jack, *Caranx hippos*. As this is the first development stage of the female after attachment to the host to be reported for the entire genus, two figures and a brief description are here given.

Young female.—Head elliptical, narrowed anteriorly, slightly projecting on either side at the center, swollen and evenly rounded posteriorly and extended backward a little over the anterior thorax. The latter joins the head not at its posterior end but on the ventral surface a little in front of it, and without definite segmentation. Nearly as wide as the head where it joins the latter, and somewhat flattened dorsoventrally, it quickly tapers backward into a narrow cylinder and passes insensibly into the abdomen. This abdomen is cylindrical and exceptionally elongated to more than forty times the length of the head. It maintains the same diameter throughout its entire length without any traces of segmentation, and the posterior end is smoothly rounded with no caudal rami.

The first antennae are turned back along the surface of the head and are almost invisible. The second antennae have two short and stout basal joints and a strong terminal claw. They are situated just beneath the frontal margin of the head, and behind them on the midline of the ventral surface projects the short mouth tube, on either side of which is a maxilla with very long setae. Farther back the second maxillae project from the ventral surface of the head, each tipped with a bifid claw. The anterior thorax carries four pairs of legs which diminish in size backward; the first two pairs are biramose, the last two pairs uniramose, all the rami two-segmented.

Total length 25 mm. Head 0.50 mm long, 0.25 mm wide.

Remarks.—Evidently the first thing that happens to the young female after attachment to the host is the excessive elongation of the body behind the head. In this there is no differentiation of body regions; thorax, genital

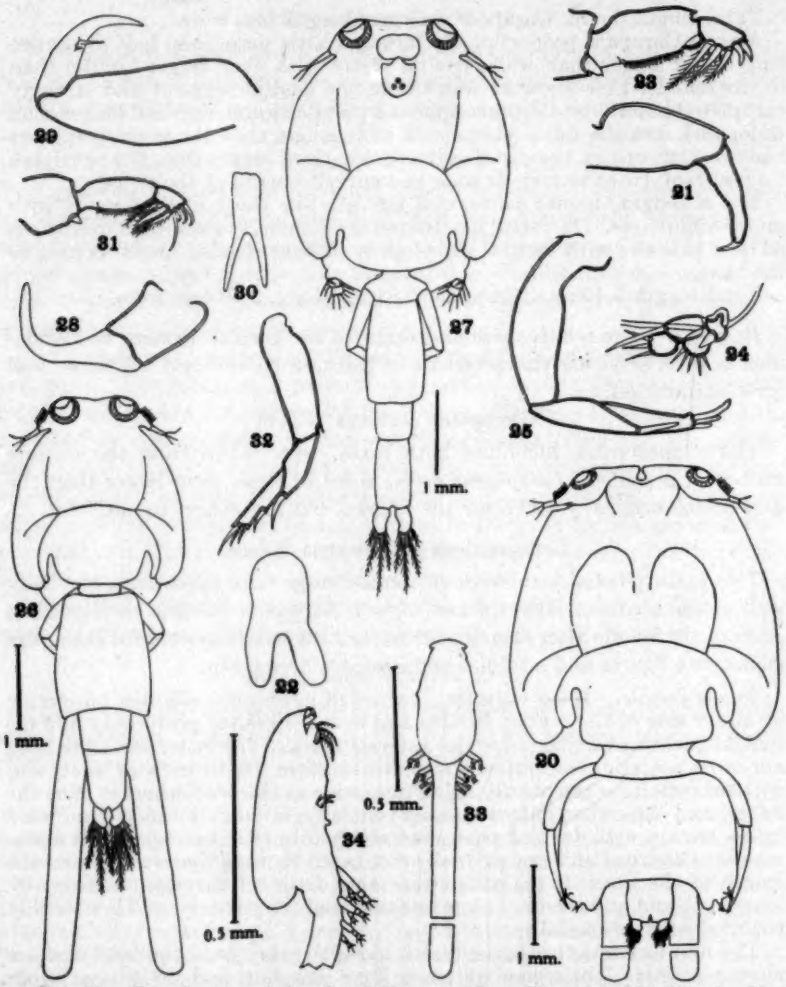

Fig. 20.—Dorsal view of female, *Caligus patulus*. Fig. 21.—Maxilliped. Fig. 22.—Furca. Fig. 23.—First leg. Fig. 24.—Third leg. Fig. 25.—Fourth leg. Fig. 26.—Dorsal view of female *Caligus tenuifurcatus*. Fig. 27.—Dorsal view of male. Fig. 28.—Second antenna of female. Fig. 29.—Maxilliped. Fig. 30.—Furca. Fig. 31.—First leg. Fig. 32.—Fourth leg. Fig. 33.—Dorsal view of a female *Lernaeenicus longiventris* just after attachment to the host. Fig. 34.—Side view of same more highly magnified.

segment, and abdomen are all the same diameter and just alike. Later, with the development of the ovaries, oviducts, and cement glands, the center of the long cylinder is swollen into the genital segment, while the anterior and posterior portions remain unchanged.

Pennella species

Two adult females were taken from the body wall of the same sailfish *Istiophorus greyi*, that yielded the Gloiopotes specimens. These were a large species, 150 mm in length or more, but as the heads were lacking in both specimens, the species could not be determined with certainty.

ORNITHOLOGY.—*Bird bones from archeological sites in Alaska.*[1]

HERBERT FRIEDMANN, U. S. National Museum.

The following collections of bird bones were gathered by Dr. A. Hrdlicka during archeological excavations in the summers of 1935 and 1936. Inasmuch as Kodiak Island was the only area worked in 1935 (also worked to a lesser extent in 1936), we may dispose of it first, and then go on to the Aleutian areas explored in 1936.

1. BIRD BONES FROM KODIAK ISLAND

During 1935, the whole season was spent on Kodiak Island, and a very large collection of bird bones was made. The bones were marked according to the depths from which they came, and therefore, by inference, dated chronologically. Dr. Hrdlicka tells me that the oldest may be 1,500–2,000 years old; the most recent are just pre-Russian, or about 150 years old. Previous collections of bird bones made in 1932 and 1934 have been reported on elsewhere[2] and a complete account of the avifauna of the island has also been published.[3]

The present collection adds but two new birds to the Kodiak list—the golden eagle and the red-legged kittiwake—a clear indication that the bird life of that area is now fairly well-known. The absence of bones of the white-winged scoter and the pigeon guillemot in the present collection is the chief point of contrast with the earlier series of bones collected on Kodiak.

The bones that were perfect enough to be useful as specimens, or that were of particular interest as records, have been saved and incorporated into the skeletal collections of the U. S. National Museum.

Gavia immer (Brunnich). Common Loon. In the 1935 excavations, bones of this bird were unearthed at all levels (superficial, intermediate, and deep)—2 humeri, 2 tibiotarsi, 3 tarsometatarsi, and 2 metacarpals. In 1936 a tarsometatarsus and a metacarpal were collected. It is not possible to identify these bones subspecifically, but the small form *elasson* Bishop is the one known (from skins) to occur on Kodiak Island.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received August 30, 1937.

[2] This JOURNAL 25: 44–51. 1935.

[3] Chicago Acad. Sci. Bull. 5: 13–54. 1935.

Gavia adamsi (Gray). Yellow-billed Loon. All but the deepest layers exposed in 1935 revealed bones of this loon—1 humerus, 3 coracoids, 3 metacarpals, 1 femur, 2 tarsometatarsi, 1 pair of mandibles, and 2 tibiotarsi. A skull was unearthed in the course of the 1936 operations.

Gavia arctica pacifica (Lawrence). Pacific Loon. The presence of osseous remains in all depths excavated indicates the regularity of occurrence of the Pacific Loon in Kodiak Island. In 1935 2 tibiotarsi, 3 tarsometatarsi, and 5 metacarpals were collected; in 1936, 1 skull, 1 femur, and 1 tarsometatarsus.

Gavia stellata (Pontoppidan). Red-throated Loon. A single tibiotarsus was collected in 1936; no bones referable to this species were gathered in 1935.

Colymbus grisegena holboelli (Reinhardt). Holboell's Grebe. Ten humeri and 9 tarsometatarsi, representing all age levels, were taken in 1935; 1 humerus was found in the 1936 collections.

Colymbus auritus Linnaeus. Horned Grebe. Two humeri, one from the deepest and one from the superficial layer, were unearthed in 1935.

Diomedea albatrus Pallas. Short-tailed Albatross. Numerous osseous parts were found at all levels in 1935—2 tibiotarsi, 1 synsacrum, 3 skulls, 1 humerus, 1 coracoid, 3 metacarpals, 8 tarsometatarsi; in 1936—1 skull, 1 synsacrum, 3 metacarpals, 2 tarsometatarsi, 1 femur, and 1 ulna.

Puffinus sp. Shearwater. The following bones, obviously those of shearwaters and probably referable to *Puffinus tenuirostris*, cannot be identified with certainty, due to lack of named comparative material. In 1935 all levels revealed a total of 14 humeri and 3 tarsometatarsi; in 1936, 2 skulls and 6 humeri were obtained.

Fulmarus glacialis rodgersi Cassin. Pacific Fulmar. A lone skull of this bird was collected in 1936.

Phalacrocorax pelagicus Pallas. Pelagic Cormorant. An abundantly represented species with all levels yielding quantities of bones. In 1935, over 200 tibiotarsi, more than 100 femurs, 66 tarsometatarsi, 165 humeri, and 28 synsacra were collected; in 1936, the material involved 1 skull, 25 humeri, 9 tibiotarsi, 2 synsacra, 1 ulna, 1 coracoid, 3 tarsometatarsi, and 5 femurs.

Cygnus columbianus (Ord). Whistling Swan. The 1935 diggings unearthed 4 fragmentary humeri and 1 synsacrum, all from the more superficial layers.

Cygnus buccinator Richardson. Trumpeter Swan. A synsacrum and 2 tarsometatarsi were found in the superficial levels and another tarsometatarsus in the intermediate depths in 1935; in 1936 a metacarpal and the head of a humerus were collected.

Philacte canagica (Sevastianoff). Emperor Goose. All age levels yielded a small number of bones of this goose in the 1935 diggings—1 tarsometatarsus, 1 femur, and 5 tibiotarsi; the 1936 operations netted 3 skulls and 3 tibiotarsi.

Anser albifrons (Scopoli). White-fronted Goose. Two tarsometatarsi, one superficial and one deep, were exhumed in 1935. This bird is still known from Kodiak Island solely on the basis of osseous remains.

Glaucionetta clangula americana (Bonaparte). Golden-eye. During the 1936 diggings, 9 humeri referable to this duck were found. The subspecific determination is based merely on the knowledge that *americana* has been found to be the subspecies of golden-eye found on the island.

Clangula hyemalis (Linnaeus). Old-squaw. The intermediate layers worked in 1935 yielded 9 humeri of this duck; the 1936 operations likewise turned up 9 humeri.

Histrionicus histrionicus (Linnaeus). Harlequin Duck. Eleven humeri, from all but the deepest deposits, were taken in 1935. They probably belong to the subspecies *pacificus* Brooks.

Polysticta stelleri (Pallas). Steller's Eider. In the 1935 diggings, 34 humeri, representing all age layers, were collected; 3 additional humeri were dug up in 1936.

Somateria v-nigra Gray. Pacific Eider. Hrdlicka obtained 1 skull, 5 humeri, and 7 tarsometatarsi in the superficial diggings in 1935; in 1936 he collected 3 skulls.

Somateria spectabilis (Linnaeus). King Eider. Large numbers of bones were found in all the layers excavated in 1935—73 coracoids, 36 tarsometatarsi, 122 humeri. In 1936 some 25 humeri and 3 tarsometatarsi were obtained.

Melanitta perspicillata (Linnaeus). Surf Scoter. In 1935 Hrdlicka collected 12 humeri, 8 from superficial deposits, 4 from intermediate depths; in 1936 he obtained 3 humeri.

Oidemia americana Swainson. American Scoter. Eight humeri, representing all depths, were collected in 1935; in 1936, in a collection much smaller in extent, no fewer than 25 humeri and 1 skull were unearthed.

Aquila chrysaetos canadensis (Linnaeus). Golden Eagle. A sternum from the superficial layers excavated in 1935 is the only record for this eagle from Kodiak Island. There is nothing surprising, however, in the occurrence of this species there, as it occurs on the neighboring mainland.

Haliaeetus leucocephalus (Linnaeus). Bald Eagle. The bald eagle is very common on Kodiak Island, and its bones were found in good numbers in all diggings during both years. In all, some 5 skulls, 4 pairs of mandibles, 23 humeri, 95 metacarpals, 2 pairs of clavicles, 2 radii, 7 ulnae, 9 sterna, 1 scapula, 18 coracoids, 12 synsacra, 14 femurs, 27 tibiotarsi, and 35 tarsometarsi were collected.

Lagopus rupestris kelloggae Grinnell. Kellogg's Ptarmigan. A single humerus and a synsacrum taken in the superficial layers in 1935 represent this bird.

Haematopus bachmani Audubon. Black Oyster Catcher. In the superficial strata dug up in 1935, Hrdlicka found a humerus of this shore-bird.

Larus hyperboreus Gunnerus. Glaucous Gull. Six tarsometatarsi were found in the upper levels in 1935.

Larus glaucescens Naumann. Glaucous-winged Gull. All depths excavated in 1935 revealed osseous remains of this gull—1 skull, 6 tarsometatarsi, 9 coracoids, and 14 humeri; in 1936 another humerus was collected.

Larus argentatus smithsonianus Coues. Herring Gull. The herring gull is represented by bones from all age levels in the 1935 diggings—5 coracoids, 24 humeri, 12 tarsometatarsi; it is also represented by 3 humeri collected in 1936. The subspecific determination is a geographic inference.

Rissa tridactyla pollicaris Ridgway. Pacific Kittiwake. Twelve humeri from all depths in the 1935 diggings are referable to this gull.

Rissa brevirostris (Bruch). Red-legged Kittiwake. Two humeri from the superficial layers of the 1935 excavations appear to represent this species, and thereby constitute the first record for Kodiak Island and a noteworthy extension in range for the gull.

Uria sp. Murre. Undoubtedly both species of murres, *Uria aalge californica* and *Uria lomvia arra*, are represented, but it is not possible to distinguish them on the basis of osseous remains. All diggings yielded large quantities of murre bones—23 skulls, 13 coracoids, 3 sterna, 3 synsacra, and about 500 humeri.

Synthliboramphus antiquus (Gmelin). Ancient Murrelet. This species is represented by 3 humeri in the 1936 collection.

Cyclorrhynchus psittacula (Pallas). Paroquet Auklet. Bones of this auklet were found sparingly in all the diggings of both years—25 humeri in all.

Aethia cristatella (Pallas). Crested Auklet. Seven humeri of this form were taken from the superficial and intermediate levels, both years.

Fratercula corniculata (Naumann). Horned Puffin. Considering the abundance of this bird on Kodiak Island, it is surprising that so few of its bones were found—2 humeri from the superficial levels of the 1935 diggings are the only bones collected.

Lunda cirrhata (Pallas). Tufted Puffin. Found in all but the deepest levels, both years. Altogether some 8 tarsometatarsi, 1 skull, and 1 humerus were unearthed.

Surnia ulula caparoch (Muller). American Hawk Owl. A skull found in the upper layers in 1935 represents this bird.

Pica pica hudsonia (Sabind). American Magpie. In the superficial levels excavated in 1935, Hrdlicka collected a skull, 1 humerus, and 1 tarsometatarsus of the magpie.

Corvus corax principalis Ridgway. Northern Raven. Commonly represented in all diggings both years. The following bones were collected: 10 skulls, 3 synsacra, 40 metacarpals, 35 humeri, and 25 tarsometatarsi.

Corvus brachyrhynchos caurinus Baird. Northwestern Crow. Found in all diggings but in much smaller quantities than the previous species—4 skulls and 7 humeri.

In the Aleutian Chain excavations were made in 1936 in four islands—Unalaska, Little Kiska, Atka, and Attu.

2. BIRD BONES FROM DUTCH HARBOR, UNALASKA

Gavia adamsi (Gray). Yellow-billed Loon. One skull, 2 tibiotarsi, 2 metacarpals, and 1 pair of mandibles represent this species.

Gavia arctica pacifica (Lawrence). Pacific Loon. A single metacarpal of this bird was collected.

Diomedea albatrus Pallas. Short-tailed Albatross. This albatross is well represented by many bones—4 humeri, 3 synsacra, 1 ulna, 4 pairs of maxillae, 1 tibiotarsus, 5 metacarpals, 9 tarsometatarsi, and 7 femurs.

Puffinus griseus (Gmelin). Sooty Shearwater. Some 18 humeri are referable to this bird.

Puffinus sp. Shearwater. The bones here included are probably to be referred to *P. tenuirostris*, but in the absence of comparative, named material, I cannot be certain.

Fulmarus glacialis rodgersi Cassin. Pacific Fulmar. Two skulls were collected.

Phalacrocorax pelagicus Pallas. Pelagic Cormorant. Represented by 16 humeri, 3 tibiotarsi, 7 femurs, and 3 tarsometatarsi.

Philacte canagica (Sevastianoff). Emperor Goose. Three humeri of the emperor goose were collected.

Nyroca valisineria (Wilson). Canvas-back. Five humeri are referable to this duck.

Glaucionetta clangula americana (Bonaparte). American Golden-eye. The subspecific determination of the single humerus collected is based on geography alone.

Clangula hyemalis (Linnaeus). Old-squaw. Of this duck 8 humeri were found.

Histrionicus histrionicus (Linnaeus). Harlequin Duck. Twelve humeri. Probably of the western subspecies, *pacificus*.

Somateria v-nigra Gray. Pacific Eider. A skull and 4 humeri represent this duck.

Somateria spectabilis (Linnaeus.) King Eider. More commonly represented than the preceding species—24 humeri and 2 skulls were found.

Melanitta deglandi (Bonaparte). White-winged Scoter. Of this species 13 humeri were collected.

Melanitta perspicillata (Linnaeus). Surf Scoter. A single humerus appears to be of this species.

Oidemia americana Swainson. American Scoter. One humerus.

Mergus merganser Linnaeus. Merganser. One humerus; probably of the American subspecies.

Haliaeetus leucocephalus (Linnaeus). Bald Eagle. Represented by 3 coracoids, 2 metacarpals, and 3 tibiotarsi. Curiously enough, 2 of the tibiotarsi had been broken and healed.

Lagopus sp. Ptarmigan. Two humeri of a ptarmigan, probably *L. rupestris*, were found.

Larus hyperboreus Gunnerus. Glaucous Gull. One femur of this gull was found.

Larus glaucescens Naumann. Glaucous-winged Gull. Of this species, 1 skull and 4 humeri were unearthed.

Larus argentatus smithsonianus Coues. Herring Gull. Six humeri.

Rissa brevirostris (Bruch). Red-legged Kittiwake. A single humerus appears to be of this species and constitutes an interesting geographical record.

Uria sp. Murres. Undoubtedly the 2 species *aalge* and *lomvia* are here mixed, but it is not possible to tell their bones apart. All in all, 148 humeri, 1 skull, and 3 tibiotarsi were found.

Cepphus columba Pallas. Pigeon Guillemot. One humerus.

Synthliboramphus antiquus (Gmelin). Ancient Auklet. Four skulls appear to be referable to this species.

Aethia cristatella (Pallas). Crested Auklet. Five humeri.

Fratercula corniculata (Naumann). Horned Puffin. One humerus.

Lunda cirrhata (Pallas). Tufted Puffin. Two humeri.

Corvus corax principalis Ridgway. Northern Raven. Of this bird, 3 humeri and 3 metacarpals were dug up.

3. BIRD BONES FROM LITTLE KISKA

Gavia immer (Brunnich). Common Loon. One humerus, 1 metacarpal, 1 tibiotarsus.

Gavia adamsi (Gray). Yellow-billed Loon. One sternum, 1 humerus, 1 tibiotarsus.

Diomedea albatrus Pallas. Short-tailed Albatross. Four tarsometatarsi, 3 metacarpals, 13 fragments of synsacra, 3 fragments of sterna, 7 humeri (5 fragments only), 5 skulls, 15 pair of maxillae, 1 pair of mandibles, 1 pair of clavicles, 15 femurs, 1 tibiotarsus.

Puffinus griseus (Gmelin). Sooty Shearwater. Two humeri.

Phalacrocorax pelagicus Pallas. Pelagic Cormorant. Three tarsometatarsi, 62 humeri, 26 femurs, 6 skulls, 14 sterna, 12 synsacra, 1 coracoid, 8 tibiotarsi.

Cygnus columbianus (Ord). Whistling Swan. Two ulnae, 2 radii.

Branta nigricans (Lawrence). Black Brant. One skull, 2 sterna.

Philacte canagica (Sevastianoff). Emperor Goose. Forty-seven humeri, 1 ulna, 2 synsacra, 3 femurs, 4 metacarpals, 3 tarsometatarsi.

Anser albifrons (Scopoli). White-fronted Goose. Eleven humeri, 2 femurs.

Mareca americana (Gmelin). Baldpate. Three humeri.

Charitonetta albeola (Linnaeus). Buffle-head. One humerus.

Clangula hyemalis (Linnaeus). Old-squaw. One humerus.

Histrionicus histrionicus (Linnaeus). Harlequin Duck. Three humeri, 1 skull.

Polysticta stelleri (Pallas). Steller's Eider. Five humeri.

Somateria v-nigra Gray. Pacific Eider. Thirteen sterna, 8 skulls, 2 clavicles, 7 metacarpals, 3 coracoids, 1 ulna, 29 humeri, 2 synsacra, 1 tarsometatarsus, 2 tibiotarsi.

Somateria spectabilis (Linnaeus). King Eider. Three humeri, 1 femur, 3 metacarpals, 3 sterna, 1 synsacrum, 1 tibiotarsus.

Melanitta deglandi (Bonaparte). White-winged Scoter. Eight humeri, 1 skull.

Melanitta perspicillata (Linnaeus). Surf Scoter. One humerus.

Mergus serrator Linnaeus. Red-breasted Merganser. One skull.

Haliaeetus leucocephalus (Linnaeus). Bald Eagle. One humerus. 2 metacarpals.

Larus hyperboreus Gunnerus. Glaucous Gull. One skull, 1 femur.

Larus glaucescens Naumann. Glaucous-winged Gull. Eight humeri, 1 femur.

Larus argentatus smithsonianus Coues. Herring Gull. Four humeri, 1 skull.

Uria sp. Murres. Probably both species *aalge* and *lomvia* mixed together. One skull, 13 humeri, 1 femur, 4 sterna.

Cepphus columba Pallas. Pigeon Guillemot. Two skulls, 8 humeri.

Brachyrhamphus marmoratus (Gmelin). Marbled Murrelet. One sternum.

Synthliboramphus antiquus (Gmelin). Ancient Murrelet. One humerus, 1 sternum.

Aethia cristatella (Pallas). Crested Auklet. Twenty-one humeri, 5 sterna.

Aethia pusilla (Pallas). Least Auklet. Three sterna.

Cerorhinca monocerata (Pallas). Rhinoceros Auklet. Three humeri.

Fratercula corniculata (Naumann). Horned Puffin. Twenty-nine humeri.

Lunda cirrhata (Pallas). Tufted Puffin. Twenty-one humeri, 4 sterna.

Nyctea nyctea (Linnaeus). Snowy Owl. One femur.

Corvus corax principalis Ridgway. Northern Raven. Eleven humeri, 3 metacarpals, 1 synsacrum.

4. BIRD BONES FROM ATKA ISLAND

Diomedea albatrus (Pallas). Short-tailed Albatross. One humerus.

Branta nigricans (Lawrence). Black Brant. One humerus.

Philacte canagica (Sevastianoff). Emperor Goose. One humerus.

Melanitta deglandi (Bonaparte). White-winged Scoter. One humerus.

Haliaeetus leucocephalus (Linnaeus). Bald Eagle. One synsacrum.

Larus glaucescens Naumann. Glaucous-winged Gull. One tibiotarsus.

Corvus corax principalis Ridgway. Northern Raven. Four humeri.

5. BIRD BONES FROM ATTU ISLAND

Diomedea albatrus Pallas. Short-tailed Albatross. Three skulls, 1 pair of maxillae, 2 synsacra, 3 tarsometatarsi, 2 metacarpals, 7 femurs.

Puffinus griseus (Gmelin). Sooty Shearwater. Five humeri.

Puffinus sp. Shearwater. Six humeri, probably *P. tenuirostris*.

Fulmarus glacialis rodgersi Cassin. Pacific Fulmar. One humerus.

Phalacrocorax pelagicus Pallas. Pelagic Cormorant. Four sterna, 3 synsacra, 4 skulls, 3 coracoids, 11 ulnae, 31 humeri, 1 tarsometatarsus, 26 femurs, and 16 tibiotarsi.

Branta nigricans (Lawrence). Black Brant. Four humeri.

Philacte canagica (Sevastianoff). Emperor Goose. One femur, 14 humeri.

Anser albifrons (Scopoli). White-fronted Goose. Two tarsometatarsi.

Somateria v-nigra Gray. Pacific Eider. One sternum, 4 skulls, 1 coracoid, 4 humeri.

Melanitta deglandi (Bonaparte.) White-winged Scoter. One humerus.

Larus hyperboreus Gunnerus. Glaucous Gull. Two skulls.

Larus glaucescens Naumann. Glaucous-winged Gull. Eleven humeri, 17 ulnae, 2 metacarpals.

Larus argentatus smithsonianus Coues. Herring Gull. Three humeri.

Larus canus brachyrhynchus Richardson. Short-billed Gull. Two humeri.

Uria sp. Murres. Four humeri, 1 skull.

Cepphus columba Pallas. Pigeon Guillemot. Two humeri.

Corvus corax principalis Ridgway. Northern Raven. Two humeri, 1 tarsometatarsus, 2 ulnae, 1 skull.

ENTOMOLOGY.—*The genus* Lysiognatha *Ashmead.*[1] R. A. CUSHMAN, Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

Many "rare" insects are rare only until something of their seasonal and environmental habits is discovered. Until the spring of 1933 *Lysiognatha* was a "rare" insect. In 1895[2] Ashmead described the genus and its type species, *comstockii*, from three specimens collected near Ithaca, N.Y., in 1872 by H. H. Smith. No other specimens had been recorded, and so far as I know only one other, a specimen without abdomen taken in Colorado by C. F. Baker and for many years reposing among unclassified material in the National Museum, had been collected.

[1] Received July 20, 1937.

[2] Proc. Ent. Soc. Wash. 3: 276. 1895.

REDISCOVERY OF LYSIOGNATHA

In 1933 J. C. Bridwell became interested in the sawflies of the genus *Xyela*, and observed them ovipositing in the young staminate cones of the Virginia pine (*Pinus virginiana*) at Clifton, Va. He also collected some of the parasitic Hymenoptera that he found frequenting the pine trees. These he submitted to me for identification. Among them I was surprised to find four female specimens representing two species of *Lysiognatha*, collected about May 1, 1933.

SEASONAL HISTORY AND BIOLOGY

On April 28 and 29, 1934, Mr. Bridwell and I visited groves of young pine trees in Virginia a few miles from Washington, D. C., and found *Lysiognatha* very abundant. At this time a large majority of the specimens were males. A week later specimens were much less numerous and all were females. This indicates that the males emerge before the females, and also that April 28 was not far from the earliest emergence date for *Lysiognatha*. During this period the larvae of *Xyela* were reaching full growth, and about May 5 were leaving the cones in large numbers. Examination of the nearly 200 specimens of *Lysiognatha* collected disclosed the same two species taken in 1933 by Mr. Bridwell and also many specimens of a third species.

While examining larvae of *Xyela* for evidence of parasitization we found many bearing on or near their heads peculiar eggs, which we were able, by comparing them with ovarian eggs, to identify as those of *Lysiognatha*. The egg of *Lysiognatha* is comparatively large, white, elongate oval, slightly curved, and slightly larger at the cephalic end. It is attached to the host by a short pedicel thrust through the skin of the host. Imbedded in the foot of the stalk is a black heavily sclerotized body that apparently serves as an anchor. Fig. 1,*b*, shows an egg dissected from the ovary of *Lysiognatha* and Fig. 1,*c*, three eggs attached to a *Xyela* larva.[3] The position of the egg on the host suggests the surmise that the peculiar mandibles of *Lysiognatha* may be employed for holding the host during oviposition.

It is very evident that hatching never takes place until after the host has entered the soil for pupation, for of the many eggs that we observed on *Xyela* larvae just after their emergence from the cones, none had hatched. In fact, it was not until July 3, more than two months after the discovery of the egg, that a newly hatched larva was observed. In hatching the larval *Lysiognatha* does not entirely

[3] Preliminary notice of the rediscovery of *Lysiognatha* and of the identity of its egg was published in Proc. Ent. Soc. Wash. 36: 262. 1934.

emerge from the eggshell, but uses it as an anchor for holding to its host.

On August 6 the first full-grown larva was found. It is a typical ichneumonid larva of the externally parasitic type, as shown by the figure of the head, Fig. 1,*d*. Subsequently many larvae were found in their thin, shining, transparent cocoons within the cocoons of *Xyela*.

The first pupa was found on September 20 and by September 26 most of the larvae had pupated. Although *Xyela* cocoons were collected and examined as late as December 17, *Lysiognatha* had not advanced beyond the pupal stage, and it is evident that it hibernates in that stage.

TAXONOMY

Position in classification.—At the time of the original description of *Lysiognatha*, Ashmead created for it the subfamily Lysiognathinae, which he placed as the first subfamily of the Ichneumonidae. In 1900, however, in his *Classification of the ichneumon flies*, he treated it as a subfamily of the Alysiidae because of the position and form of the mandibles. The Spanish hymenopterist, G. Ceballos, examined the types of *L. comstockii* at the National Museum in 1928, and subsequently[4] expressed the opinion that it is ichneumonid.

In my opinion the cephalic and mandibular characters are adaptive, whereas the venation and the free second abdominal suture, together with the characters of the larva, are phylogenetic characters and hence of much more significance in determining the affinities of the group. In venation and abdominal structure there is no essential difference between *Lysiognatha* and many ichneumonid, especially ichneumonine, genera, and it is to the Ichneumonidae that I think it should be relegated.

The association of *Lysiognatha* with the primitive *Xyela* would seem to indicate a primitive position for it within the Ichneumonidae. On the other hand, the form of the head and of the mandibles and the method of reproduction indicate a much more recent origin than that of many other Ichneumonidae. Whatever the placing, the form of the head and of the mandibles would render the group anomalous. In the more conservative characters of venation, form of abdomen, and form of ovipositor it is perhaps most like the Ichneumonini, while its method of reproduction allies it with the Tryphonini. In my opinion the proper placing of the group is low on the phylogenetic line between the Ichneumonini and the Tryphonini. The anomalous form of the head and that of the mandibles are sufficient to warrant the recognition of the Lysiognathinae as a distinct subfamily.

[4] Mem. Real Soc. Esp. Hist. Nat. 25: 20. 1929.

Subfamily and generic characters.—Head in front view (Fig. 1,*a*) broader than long, with mouth very broad, mandibles articulating below eyes, the articulating membrane extending upward behind eyes; malar space obliterated; mandible nearly twice as long as broad at base, nearly parallel sided, with two large, slightly out-turned teeth, from each of which a prominent carina runs back along margin toward base so that outer face of mandible toward apex is concave; clypeus correspondingly broad, extending from eye to eye, ten or more times as broad as long medially, where it is

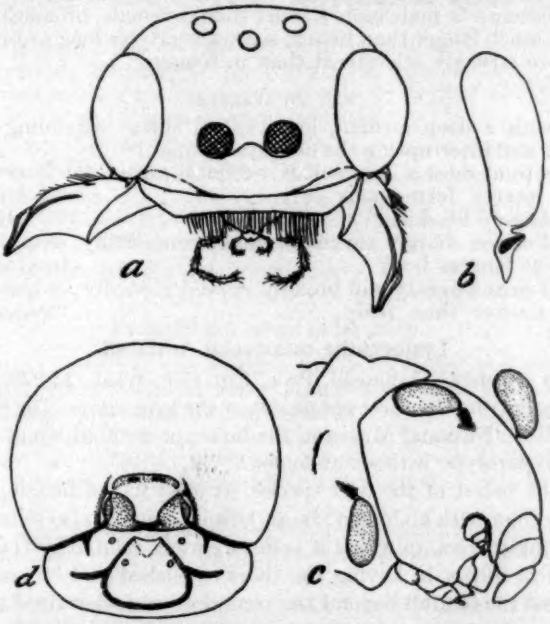

Fig. 1.—*a*, head of *Lysiognatha longicauda* Cushman; *b*, ovarian egg of *Lysiognatha* sp.; *c*, eggs of *Lysiognatha* sp. *in situ* on larva of *Xyela* sp.; *d*, head of larva of *Lysiognatha* sp.

shortest; maxillary palpus 5-jointed; labial palpus 4-jointed (erroneously given as 3-jointed by Ashmead); head behind eyes buccate, temple nearly or quite reaching outside tangent of eye, occiput deeply concave and margined by a distinct carina; antennae short, slender, filiform, about 22–25-jointed, scape semiglobose, squarely truncate at apex, first joint of flagellum shorter than second and slightly thickened toward base.

Thorax stout, shining, weakly sculptured; epomia lacking; notauli shallow; sternauli lacking; prepectus defined; mesolcus deep, not closed posteriorly; propodeum incompletely areolated, median carinae diverging from base to apex, basal area small quadrangular, areola and petiolar area confluent; lateral carinae present or absent; spiracle very small, circular, situated somewhat before middle.

Legs stout, rather long; calcaria 1:2:2, short, inner calcaria on middle and hind legs not much longer than outer; claws small, simple.

Wings broad; stigma broadly triangular; areolet deltoid, oblique, sessile or petiolate; second recurrent with separated bullae; second discoidal cell broad at base; abscissula shorter than intercubitella; nervellus broken below middle.

Abdomen in female short and broad, sessile, little longer than thorax; first tergite large, slightly longer than broad, sides divergent, dorsal carinae extending well onto disk, spiracle basad of middle; other tergites strongly transverse, apical ones weakly sclerotized; ovipositor long, subsagittate but not serrate at apex; hypopygium rather prominent; venter entirely membranous. Abdomen in male more slender than in female, broadest near apex; first tergite much longer than broad; second nearly as long as broad; apical tergites more strongly sclerotized than in female.

KEY TO SPECIES

1. Vertex with a deep median, longitudinal sulcus extending back onto occiput and interrupting the occipital carina.....2
   Vertex with at most a faint sulcus; occipital carina not interupted....3
2. Female largely ferruginous.....*comstockii* Ashmead
   Female largely blackish.....*sulcata*, n.sp.
3. Occipital carina sharply curved or angulate medially; ovipositor sheath nearly as long as body.....*longicauda*, n. sp.
   Occipital carina evenly and broadly curved medially; ovipositor sheath much shorter than body.....*bridwelli*, n. sp.

Lysiognatha comstockii Ashmead

Lysiognatha comstockii Ashmead, Proc. Ent. Soc. Wash. **3**: 276. 1895.

Known only from the three specimens of the type-series. The two females are in the U. S. National Museum, the holotype without wings and antennae and the paratype without abdomen.

This is the palest of the four species, at least in the female, being of a ferruginous color with abdomen almost stramineous. It also differs from the next following species, to which it is most closely related by the possession of the vertical sulcus, in having the thorax polished and virtually without sculpture and the tergites beyond the second evenly sclerotized throughout.

Lysiognatha sulcata, n. sp.

Closely related to *comstockii* and possibly not distinct, but judging from the meager material in both species it differs constantly in the female in the blackish head and thorax and the more distinctly sculptured and less polished thorax, and in having the tergites beyond the first so weakly sclerotized along the apical and lateral margins that in dried specimens they are much distorted. The last may be due to a teneral condition, but the fully developed color argues against this possibility. Furthermore, the difference of nearly two months in the collecting dates could hardly be accounted for by the difference in latitude.

Female.—Length 3.25 mm; antenna 2.75 mm; ovipositor sheath 1.75 mm.

Head polished, virtually without sculpture; a deep sulcus extending from between the ocelli nearly to the occipital foramen and interrupting the occipital carina.

Thorax subpolished, subtly alutaceous; mesoscutum weakly and sparsely punctate; propodeum more strongly alutaceous, the carinae faint; areolet sessile.

Abdomen beyond first tergite weakly sclerotized around margins of tergites, first tergite subpolished, distinctly longer than broad.

Black; face, clypeus, mouthparts (except mandibular teeth), lower margin of cheek, frontal orbit, under side of scape, of pedicel, and of base of first flagellar joint, tegulae, radices of wings, and front and middle coxae and all trochanters whitish; abdomen beyond first tergite brown fading to yellowish toward apex; wings hyaline, stigma testaceous, veins darker; front and middle femora pale stramineous, their tibiae and tarsi somewhat infuscate; hind coxa piceous with apex pale, femur stramineous, tibia and tarsus fuscous.

Male.—Essentially like female except that abdomen is narrower and evenly sclerotized; first tergite nearly twice as long as broad with sides parallel beyond spiracles; abdomen darker, with tergites except first margined with yellow; and stigma fusco-testaceous.

Type-locality.—Clifton, Va.

Type.—No. 52160, U. S. National Museum.

Two females from the type-locality Apr. 26–May 3, 1933; 2 males, Dalecarlia, D. C., June 1, 1934, and one male, Alexandria, Va., Apr. 28, 1934; all taken by J. C. Bridwell on *Pinus virginiana*.

Lysiognatha longicauda, n. sp.

Distinct from *sulcata* in the obsolete sulcus of vertex and merely angulated, not interrupted, occipital carina; and, in the female, in the completely sclerotized tergites and much longer ovipositor.

Female.—Length 3.25 mm; antenna 2.75 mm; ovipositor sheath 2.75 mm.

Head finely but distinctly punctate; sulcus of vertex distinct only just before occipital carina, which has a distinct angulation but is not interrupted medially.

Thorax shining, alutaceous especially on pleura and propodeum, mesoscutum and scutellum distinctly finely punctate; propodeal carinae distinct; areolet subsessile or petiolate.

Abdominal tergites completely sclerotized; first tergite distinctly alutaceous, very slightly longer than broad.

Color pattern the same as in *sulcata*, but the dark color more piceous, sometimes largely replaced by reddish; dorsal part of head, scutellum and the thoracic sutures frequently paler; legs usually darker; abdomen beyond first tergite, except apical 2 or 3 tergites, piceous; stigma fusco-testaceous, paler at base and apex.

Male.—Abdomen more slender than in female, first tergite nearly twice as long as broad; dark color of head and thorax black, rather than piceous; abdomen dorsally piceous, except narrow yellowish margins of tergites.

Host.—*Xyela* sp.

Type locality.—Alexandria, Va.

Type.—No. 52161, U. S. National Museum.

Forty-six females and 54 males taken on pine at Clifton, Va. (Apr. 26–May 3, 1933), Alexandria, Va. (Apr. 28, May 2 and May 6, 1934), and Barcroft, Va. (May 6, 1934), all by J. C. Bridwell, and at Falls Church, Va. (Apr. 29 and May 6, 1934) by R. A. Cushman.

Lysiognatha bridwelli, n. sp.

Female.—Length 3.0 mm; antenna 2.0 mm; ovipositor sheath 1.75 mm. Distinct from all of the other species in the evenly curved, neither interrupted nor angulated occipital carina and barely visible median sulcus of vertex; and from *longicauda*, which it most closely resembles, in the much shorter ovipositor. Otherwise the species agrees with the above description of *longicauda*, except that the ground color of head and thorax, whether piceous or reddish, is more nearly uniform.

Male.—Differs from the female as does the male of *longicauda* from its female.

Host.—*Xyela* sp.

Type locality.—Alexandria, Va.

Type.—No. 52162, U. S. National Museum.

Thirty-nine females and 38 males taken on pine at Alexandria, Va. (Apr. 28–29 and May 2 and 6, 1934), Barcroft, Va. (May 6, 1934), and Dalecarlia, D. C. (May 1, 1934) by J. C. Bridwell, and at Falls Church, Va. (Apr. 29 and May 6, 1934) by R. A. Cushman.

MALACOLOGY.—*Four new species of fresh-water mollusks from China.*[1]

SUI FONG CHEN. (Communicated by PAUL BARTSCH.)

In a collection of Chinese fresh-water mollusks received by the U. S. National Museum from the Rev. D. C. Graham are four undescribed species which are here described and named.

I wish here to express my appreciation to the authorities of the U. S. National Museum and to Dr. Paul Bartsch, the Curator of the Division of Mollusks, for the privilege of studying the family Melanidae from China in their collection.

Melania (Melanoides) suifuensis, n. sp. Figs. 1, 2.—1

Shell of medium size, stout, elongate-conic, turreted, pale yellow throughout excepting the interior of the aperture, which is whitish. The nuclear whorls are decollated in all the specimens before me. Postnuclear whorls well rounded, marked with axial crescentic ribs of which 14 occur on the second and third of the remaining whorls, 15 on the fourth, 17 on the fifth and sixth, 19 on the penultimate, and 18 on the last whorl. The spaces separating the ribs about equal them in width. The spiral sculpture consists of fine threads of which 16 occur between summit and periphery on the last whorl. The suture is strongly impressed. Periphery strongly angulated with the axial ribs terminating at the angulation. Base short, well rounded, and marked by the feeble continuations of the axial ribs; it is also marked by obsolete microscopic spiral threads. The aperture is elliptical; the peristome is thin, simple; parietal wall covered with a slight callus; columella arched. The operculum is thin with 3.2 turns and has left subcentral nucleus. The radula has the formula: 3-1-3:2-1-3:4:5.

The type of U.S.N.M. Cat. No. 365666, was collected by Rev. D. C. Graham at Suifu, Szechuan Province, China. It has 8 whorls remaining

[1] Published by permission of the Secretary of the Smithsonian Institution. Received July 30, 1937.

which yields the following measurements: Length 21.1 mm; diameter 8.0 mm; length of aperture 6.6 mm.

Twenty-one specimens from the same source as the type, yield the following additional information: They have an average number of 7.9 whorls; the greatest number of whorls being 9.1, and the least 7.2. They present an average length of 18.6 mm; the greatest length being 20.9 mm, and the least 15.8 mm. Their average diameter is 7.0 mm; the largest is 7.8 mm. and the least 5.9 mm. The length of aperture averages 5.9 mm; the largest length of aperture is 6.5 mm, and the least 5.2 mm. They have an average number of ribs as follows: 14.7 on the second of the remaining whorls, 14.6 on the third, 14.8 on the fourth, 15.5 on the fifth, 17.0 on the sixth, 18.0 on the seventh and last whorls.

This species resembles *Melania ningpoensis* Lea, but lacks the spiral keels on the base.

Fig. 1.—1, *Melania* (*Melanoides*) *suifuensis*. ×2. 2, *Paludomus* (*Hemimitra*) *yunnanensis*. ×5. 3, *Paludomus* (*Hemimitra*) *kweichowensis*. ×5. 4, *Paludomus minensis*. ×2.

Paludomus (Hemimitra) yunnanensis, n. sp. Figs. 1, 2.—2

Shell quite small, ovate-conic, olive brown. Nuclear whorls eroded in all the specimens before me. Postnuclear whorls inflated, strongly rounded, and marked with microscopic incremental lines; spiral sculpture absent. The last whorl shows three dark brown bands. The first which is much narrower and darker is a little below the summit, the second one is half way between the first and third, the latter being at the periphery; a lighter zone equalling the medium dark band separates this from the other two. The suture is well impressed. The last whorl is rather inflated with rounded periphery. The base is short, well rounded, with a dark brown median spiral band. Aperture pyriform; peristome thin, simple; parietal wall with a thin callus; columella arched. The operculum is thin, horny with 2.4 turns, bluntly pointed posteriorly, and broadening anteriorly with subcentral nucleus. The radula has the formula: 2-1-2:2-1-3:6:11.

The type, U.S.N.M. Cat. No. 467598, was collected by Rev. D. C. Graham in the Yangtze River, near Shiikiang, Yunnan Province. China, and yields the following measurements: Number of whorls 3.0; length 6.9 mm; diameter 4.5 mm; length of aperture 4.0 mm.

Twenty-nine specimens from the same source give us the following additional information: They have an average number of 2.9 whorls remaining; the greatest number of whorls is 3.3, and the least 2.3. They present an average length of 5.7 mm; the greatest length is 7.3 mm, and the least 3.6 mm. Their average diameter is 4.0 mm; the largest is 4.8 mm, and the least 2.6 mm. The length of aperture averages 3.4 mm; the largest length of aperture is 4.3 mm, and the least 2.2 mm.

This species is also found in Suifu, Szechuan Province, China. Twenty-two specimens, U. S. National Museum Cat. No. 467599, collected by Rev. D. C. Graham, give the following measurements: They have an average number of 3.0 whorls remaining; the greatest number of whorls is 3.6, and the least 2.1. They present an average length of 5.6 mm; the greatest length is 7.1 mm, and the least 4.5 mm. Their average diameter is 4.0 mm; the largest is 4.9 mm, and the least 3.2 mm. The length of aperture averages 3.3 mm; the largest length of aperture is 4.0 mm, and the least 2.5 mm.

This species resembles *Paludomus baccula* Reeve in many respects but it is much smaller, and the anterior end of the aperture is more pointed; it is also spirally banded.

Paludomus (Hemimitra) kweichowensis, n. sp. Figs. 1, 2.—3

Shell rather small, solid, smooth, elongate-conic, dark brown throughout excepting that part immediately below the suture which is greenish yellow. The apex is eroded. The postnuclear whorls are inflated, well rounded, and marked with fine lines of growth. Spiral sculpture is absent. Three spiral dark brown bands are present on each whorl; they are especially conspicuous on the last turn. One of these, much narrower, is slightly below the summit, the second one, much lighter than the other two, is half way between the first and third, the latter being at the periphery; a lighter zone equalling the medium dark band separates this from the other two; there may also be a more or less well developed basal band. Suture strongly impressed. Periphery well rounded. The base is moderately long and well rounded. The aperture is ovate-pyriform; peristome simple, slightly reflexed; parietal wall covered with a slight callus; columella arched. The operculum is thin with 3.2 turns, ovate, bluntly pointed posteriorly and broadly rounded anteriorly with subcentral nucleus, that is somewhat to the left of and below the center. The radula has the formula: 3-1-3:2-1-3:5:8.

The type, U.S.N.M. Cat. No. 467596 was collected by Rev. D. C. Graham at Shih-men-kan, Kweichow Province, China. It has 6.5 whorls and measures: Length 10.7 mm; diameter 5.7 mm; length of aperture 5.0 mm.

Ninety-three additional specimens from the same source give the following measurements: They have an average number of whorls 5.0; the greatest number of whorls is 6.5, and the least 3.8. They present an average length of 9.7 mm; the greatest length is 13.5 mm, and the least 5.6 mm. Their average diameter is 5.2 mm; the largest is 6.2 mm, and the least 3.5 mm. The length of aperture averages 4.6 mm; the largest length of aperture is 5.9 mm, and the least 3.0 mm.

This species is very much like *Melania leprosa* Heude, but is much smaller and has the columella more uniformly arched, and the body whorl larger; it is also spirally banded.

Paludomus minensis, n. sp. Figs. 1, 2.—4

Shell thick, stout, ovate, bluish purple covered with a greenish yellow periostracum; the interior of the aperture is chestnut colored. Nuclear

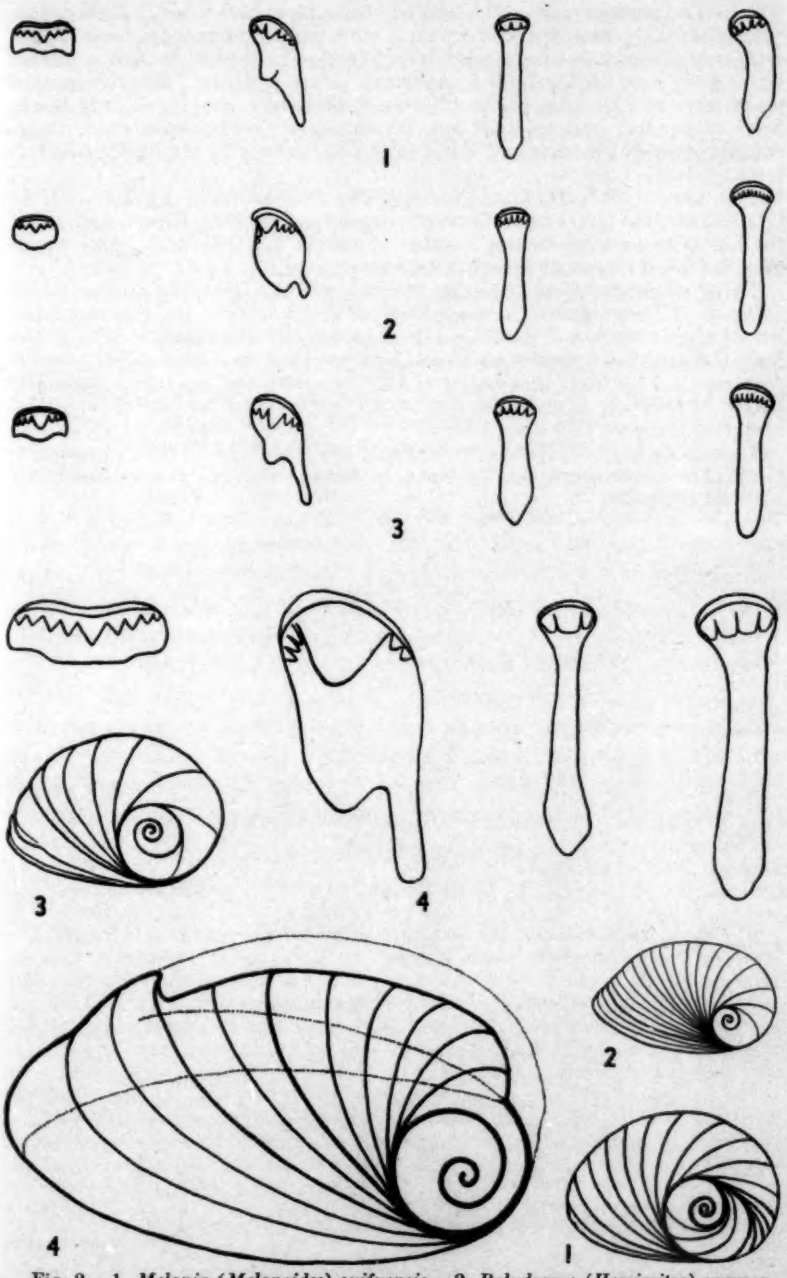

Fig. 2.—1, *Melania (Melanoides) suifuensis*. 2, *Paludomus (Hemimitra) yunnanensis*. 3, *Paludomus (Hemimitra) kweichowensis*. 4, *Paludomus minensis*. Radulae, ×200. Opercula, ×15.

whorls 2.0, smooth and well rounded, forming a blunt apex. Postnuclear whorls strongly rounded and marked with axial incremental lines. Spiral sculpture absent. Suture moderately impressed. Periphery well rounded. Base short and well rounded. Aperture ovate-pyriform, bluntly pointed posteriorly and broadly ovate anteriorly; peristome simple, slightly thickened internally; parietal wall heavily calloused; columella arched. Operculum ovate and moderately thick, with 2.7 turns. The radula has the formula: 4-1-4:3-1-2:3:4.

The type U.S.N.M. Cat. No. 467605, was collected by Rev. D. C. Graham in Min River near Kienway, Szechuan Province, China, and yields the following measurements: Number of whorls, 4.8; length 21.2 mm; diameter 15.1 mm; length of aperture 12.9 mm.

Three specimens from the same source yield the following additional information: They have an average number of 4.4 whorls; the greatest number of whorls is 4.6, and the least 4.2. They present an average length of 22.2 mm; the greatest length is 23.3 mm, and the least 21.6 mm. Their average diameter is 14.9 mm; the largest is 15.6 mm, and the least 14.1 mm. The length of aperture averages 13.4 mm; the largest length of aperture is 13.7 mm, and the least 12.9 mm.

The species, most closely resembling this form, is *Paludomus conicus* Gray. The present species, however, is stouter and has a smooth surface without sculpture.